CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Hoover Heads The A.I.M.E.

THE American Institute of Mining and Metallurgical Engineers is honored in the election of Mr. HOOVER to its presidency for 1920. Leadership in the A.I.M.E. has been on a high plane for many years, but in no recent instance has the incumbent of the office been a man who had attained international reputation in the prime of life. In his forty-sixth year Mr. HOOVER has reached an eminence, not only in the engineering profession but in citizenship, which is achieved by few men at the end of the proverbial threescore years and ten. Through him engineering will receive recognition by the public at large and the engineer's training and kind of thinking will be hailed as a power to be reckoned with in public affairs. It goes without saying that the welfare of the Institute will be enhanced under his leadership.

Government Nitrate Plants Should Be Operated

NITROGEN and its compounds comprise one of the most important chemical topics now before the American people, almost regardless of the avenue through which it may be approached—technical, political, commercial or economic. Technically, the fixation processes are receiving the closest study and attention of our chemical engineers. Politically, the subject acquires importance from the fact that the Government owns fixation plants constructed in war time. Commercially, it may affect our relations with other countries. And as for the economics of the matter, the future independence of nations may be bound up in it. In view of the evident importance of the subject, we shall devote to its consideration an unusual amount of space during the next few months, and authoritative articles will be presented on all its phases.

For a clear preliminary view of the economic situation in the United States we refer the reader to an article by ALFRED H. WHITE, published elsewhere in this issue. It merits the serious consideration of all who are concerned with inorganic fixed nitrogen. The author is connected with none of the conflicting commercial and political interests, and expresses independent views. As a Colonel in the Ordnance Department during the war he was in a position to review all the reports and figures bearing on production and research. He is of the opinion that the Government nitrate plants should be operated, and a careful study of the curves which he presents will show how lightly the operation of these plants will affect commercial enterprise.

As a result of an independent editorial investigation we are in accord with Dr. WHITE regarding the advisability of operating the Government's nitrate plants.

The subject has many phases which will develop later, but for the present it is sufficient to note that there is a demand for the operation of the plants as a matter of preparedness and for the development of fixation processes through research. The agriculturists' demand for inorganic fixed nitrogen is rapidly increasing due to the shortage of organic ammoniates. The construction of a new commercial synthetic ammonia plant by the General Chemical and Solvay interests, themselves in the byproduct coke business, refutes the testimony of Mr. ATWATER of The Barrett Company before the Graham House committee, to the effect that byproduct ammonium sulphate will be sufficient for fertilizer needs. Germany and France are proceeding with the operation of their cyanamide and Haber plants and the English Nitrate Committee has just recommended the immediate erection of both types of plant by the British Government. As for Chilean nitrate, producers of that material are not alarmed at possible competition from Government plants, as the farmer is well educated to the use of Chilean saltpeter. The material is an acceptable fertilizer and the supply reliable.

A great deal of dust has been thrown up in political and commercial circles intending to obscure the clear-cut issues of the whole nitrogen problem. But when this is cleared away we believe that one fact will stand out clearly, namely, that the Government should preserve, operate and develop its plants at Muscle Shoals. The facts on which this policy is based will be presented in subsequent issues of CHEMICAL & METALLURGICAL ENGINEERING.

Increased Demand for Laboratory Facilities

THERE is a constant demand in New York for more laboratories by men who want to prosecute research. The Chemists' Club could dispose of twice the number at its command, and at Columbia University there is a constant appeal for laboratory facilities for private research which cannot be granted. Laboratories are generally crowded.

According to an estimate made by Professor MCKEE, approximately 35 per cent of the country's chemical industries are established within commuting distance of New York, while the second largest complex of applied chemical interests is 5 per cent of the whole, to be found in the neighborhood of Niagara Falls and Buffalo. This may explain why so many chemists engage in research in the metropolitan district. It is open to question whether a large laboratory building with the usual facilities for experimental work and small-scale technical apparatus available for try-outs on a larger scale would be a profitable enterprise. Results are often negative, and very few of our business men are chemically intelligent. The worst feature of applied chemistry

in the United States is that men of other than chemical affairs do not know how to discriminate among chemists. Therefore the incompetent man is often set at research and maintained by far too long a time at his task, while the competent man with good ideas cannot get support, or is halted at the very brink of success.

The demand for laboratories, however, is intense, and there is abundant opportunity for someone or some organization to render a service to industry by supplying the needed facilities. What the country needs is some place where tests and experiments could be performed quickly. Time is usually an important element in the development of an idea, and adequate facilities immediately available would conserve time. Given a laboratory with steam, gas, water, electricity, compressed air, and the requisite apparatus, all probably requiring an investment of at least $5,000 if undertaken privately by each investigator, a competent man would be equipped to carry to early completion a line of research already outlined in his mind. The need of such facilities is imminent. Who can be found with sufficient interest to supply them?

The Ideal of National Industrial Independence

FOR the past five or six years the subject of post-war conditions in the world's leading nations has been, and no doubt will continue for some time to be, a fertile topic for writers on sociology and economics. If one is inclined to question the truth of this assertion, he has only to observe the abundance of this kind of literature published both here and abroad, for there has been a wealth of thought devoted to past and future industrial attainments.

The trend of practically all the post-war economic literature has been toward the ideal status of national industrial independence. This is a logical consequence of the fact that nearly every country was brought to a full realization of what industrial dependence implies, when confronted with the abnormal requirements of war. To a degree more or less acute each and every nation found itself in a position of an improvident man who always prefixes his excuses with an "if." If, for example, for a few decades prior to the war American technologists had not limited their progress to industries based mainly on inorganic chemistry, but had broadened their activities to include industrial organic chemistry, how much more favorable our position would have been when we entered the war! Similarly each of the other nations found it convenient to explain some phase of its dependence with an "if." But national development, like that of the individual, does not always take into consideration the extreme emergency; nor is national independence in industrial matters so simple or easy of attainment as might be imagined. The fact is and always will be that we must take into consideration many ethnological, geographical and economic conditions and their numerous corollaries when trying to appraise the actual or prospective development of industry in the different nations.

No doubt each country that was in the war will strive to attain industrial independence and will tax its abilities to the utmost for realization of this aim, but very few, if any, will succeed. Failure will not be due to any lack of determination or initiative, but solely to the inherent difference in conditions just mentioned.

At first sight we may be greatly encouraged by the progress made in the United States and elsewhere in new industries introduced during the period of war, but we have only to realize how abruptly these developments stopped at the end of the war to see that their rapid growth was made at the expense of other more natural and congenial attainments. Evolution and not revolution is the only basis for progress in a sound industrial program.

In our own United States it is apparent that assimilation and not imitation was the reason why the twentieth-century American people—the so-called melting pot product—withstood practically with immunity the acid test of a great nation. The same thought applies to twentieth-century American industry. The logical post-war prospect for industrial achievement will be determined largely by the spirit of the people and the natural resources of the country. Pre-war times furnished abundant examples of our industrial creative ability. War times showed our relatively rapid progress in new industries hastily produced. It now remains for us in the post-war period to assimilate as thoroughly as possible the hastily introduced industries, especially those based on organic chemistry and the allied sciences. It is only by logical assimilation in harmony with the spirit of the American people and America's natural resources that we can ultimately attain the goal of industrial independence.

An Interpretation of Coke Statistics

THE 1919 coke-production figures of the United States Geological Survey, just announced, suggest some interesting possibilities of future development in the coking of coal in this country. We are told that approximately twenty-five million tons of byproduct coke and nearly twenty million tons of beehive coke were made last year in this country. If we assume the same percentage yield of coke from the coal as during previous years, it means that about thirty-five million tons of coal was used in the byproduct process and thirty-one million tons in beehive ovens.

This is the first time that we have had a larger tonnage of coal used and coke produced in the byproduct process than in beehive ovens, and nationally we can congratulate ourselves on this evidence of real progress. The exact figures show an increase from 46 per cent in 1918 to 56 per cent for 1919 of the total coke production by the byproduct method.

It has been estimated, however, that only about 70 per cent of the possible byproduct oven capacity was utilized in coke production last year. This low percentage was, of course, the result of the coal strike and the steel strike, which greatly aggravated the usual causes of interruptions or low-capacity operation. It is rather interesting to see just what it would have meant if the byproduct ovens could have operated at full capacity. If this had been possible, the coal consumption for the year in this process would have been fully fifty million tons, and the coke production over thirty-five million tons, or 80 per cent of the total coke produced and used last year.

Of course no one believes that 100 per cent capacity will ever be attained in any such industrial process, but 85 to 87 per cent has been demonstrated as entirely feasible, and even 90 to 92 per cent has been attained in certain plants or for certain periods throughout the whole country. If 90 per cent capacity had been

attained, forty-five million tons of coal would have produced about thirty-two million tons of byproduct coke, or over 70 per cent of the actual production for the past year.

Any single industry that uses as much as 12 per cent of our total coal production, as was the case last year in coke manufacture, is worthy of our careful thought at any time; and this particular aspect of the case is especially interesting when we see what a large change in operating conditions and results would have been accomplished if industrial conditions had permitted more nearly normal or even above normal utilization of the available byproduct capacity. It is especially interesting to note that of the sixty-six million tons of coal used in making coke last year, nearly a million tons could have been saved had it been possible to utilize the byproduct process to 90 per cent capacity instead of only 70 per cent and have the beehive operation correspondingly curtailed. Naturally, geographical distribution of the ovens and various company connections make any such change as this rather unlikely; but the large economic significance of such change cannot be safely ignored by anyone concerned in the coal business. It is only a question how long such an economic waste will be allowed to continue without the deserved change in practice.

Dr. Edgar F. Smith Offers His Resignation

THE Provost of the University of Pennsylvania, Dr. EDGAR F. SMITH, has tendered his resignation to the trustees and the trustees have refused to accept it, urging him to continue his labors with them. His years of service have been many, he having begun as instructor in chemistry at the same university in 1876, when he was twenty years of age. He took his bachelor's degree in science when he was eighteen, his doctorate in philosophy at Göttingen at twenty, and since then honorary degrees have been showered upon him in abundance but not beyond his deserts. He is now, at the age of sixty-three, in possession of the great wealth of his faculties, and we hope he may long continue to exercise his beneficent gifts in authority, in teaching, in research and in literature.

He is a great teacher of chemistry. In unusual measure he arouses the intellectual curiosity of his students and thus overcomes the contempt for learning that is an ever-present danger in a number of American colleges and universities. He has also the gift of good fellowship along with the charm of social distinction, of *savoir faire*, of elegance and of grace. These qualities increase his influence among students and make manifest to them, at the same time, the pleasures of scholarship as well as its usefulness.

While keenly alive to his responsibilities, he is utterly neglectful of his rewards in money or property. When the alumni presented him with a house, he declared it was too ostentatious for him and proposed that it be leased to help students in need. He has never tried to get rich; his work in hand was always too interesting to bother about returns from that already done. And he is intensely loyal to his boys.

His contributions in research have been of primary importance. He was a pioneer in electro-analysis and his work in mineral analysis is as great a contribution to mineralogy as it is to chemistry. In a number of respects he established present-day laboratory practice.

The city of Philadelphia is a social institution in itself, and it is replete with old ladies of all ages and sexes. There are illusions of Heaven which obtain there that are even more firmly fixed in the public consciousness than the illusions of the mind in Boston, of smartness in New York, of pounds pressure per square inch in Chicago or of authority in London. According to Philadelphia tradition the incumbent of the office of Provost of the University is *ex officio* a member of its heavenly choir; but here also Dr. SMITH has not failed. He is a very acceptable man.

He has drawn aside the veil of yesterday and introduced to us the shades of our own men of weight in chemistry. Without his delightful monographs and biographies we should have left in the limbo of forgetfulness that splendid galaxy who wrought well for American scholarship in science in the late eighteenth and early nineteen centuries. It is no less than a passion with him to do justice to these men. He has no interest in the minor gossip of the day, and so he is probably still unaware of a curious little side reaction which followed his Life of Robert Hare. In it, so far as we remember, he failed to tell how ROBERT got himself into trouble with certain persons of consequence in his native city and lived for the remainder of his days under somewhat of a social cloud. He was invited to be a member of the committee in charge of an annual assembly ball to which only the elect were bidden. He neither accepted nor declined; he did not even answer the letter! Nothing imaginable could excuse such a fault, and it was never forgiven. His relatives bore the burden, probably with fortitude, but, for aught we know, with bowed heads. He left a single daughter who inherited but little from him and who, after a life in modesty, went the way of all flesh in the maturity of her years.

He had, however, many nephews and nieces. The generations continued and they numbered prominent persons, including a famous bishop, but Uncle ROBERT'S name was seldom mentioned. Whatever his merits they were drowned in the overwhelming flood of his fault in regard to The Assembly. They came Dr. SMITH'S book, which showed him to be truly a great man, while chemistry emerged into fashion with the war. So garrets have been ransacked and now the likeness of Uncle ROBERT hangs in glory and reminders of him have prominent place in the houses of those who willingly forgot him a few years ago.

The only thing that would modify our regret if Dr. SMITH should leave the University of Pennsylvania would be for him to come to New York to live, so that we might see more of him.

Acid Fumes On Riverside Drive

IN RESPONSE to the complaint made by the residents along Riverside Drive, New York City, that the acid fumes from the New Jersey factories are obnoxious, the city chemist has investigated with the result that ten gallons of sulphuric acid are found in every 53,790 gallons of rain water falling in this section.

This seems about the proper amount to give a healthy tang to the air. Chemists will agree that acquaintance with the odor may be cultivated until it becomes delightful to the most effete nostril. One should really learn to know and care for our industrial scents. They are inseparable parts of institutions that make Riverside Drives possible.

Readers' Views and Comments

Atomic Structure of Metals in Solid Solution

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the article contributed to the issue of your magazine of Nov. 5, Dr. A. L. Feild pointed out the fact that, in the cases of the binary alloys Ag-Au, Ag-Cu, Cu-Ni and (probably) Ni-Cr, the maximal electrical resistance of the solid solutions are those which would be given by the rule of mixtures, if the resistances of the pure metals were assumed to have the values yielded by extrapolation from above the melting points. This relationship, if it be found to obtain for alloys in general, must possess a theoretical significance; but the conclusion which has been drawn appears to be open to serious objections.

This conclusion is essentially the following: In forming solid solutions the component metals do not wholly crystallize, but remain in part amorphous, with the properties of undercooled liquids, as in the intercrystalline cement of the theory of Beilby and Rosenhain; the resistance of the solid solution results additively from those of its amorphous components, but is not a linear function of the composition of the alloy, since the fraction of each metal which remains amorphous is determined by the proportion in which the other metal is present, the amorphous fraction of A increasing with addition of B, and *vice versa*.

The conception accords, at least, qualitatively, with the arched forms shown by resistance-composition curves. But it explains the relation in question only if it be supposed that, for the composition of maximum resistance, which is approximately 50 : 50 in each instance, suppression of crystallization is complete in both metals, so that such an alloy is wholly amorphous. For unless a 50 per cent alloy contains both metals in an entirely amorphous state there is no evident reason why its resistance should be the mean of the resistances which the components might be expected to possess if in a non-crystalline condition.

This seemingly inevitable corollary renders it very difficult to admit the assumption that suppression of crystallization in the formation of solid solutions is accountable for their low conductivities. For the alloys of mineral conductivity possess a crystalline appearance and character as pronounced as that shown by those of any other composition; and moreover, they do not solidify in the manner to be expected of substances which remain amorphous, but instead freeze at a constant temperature, undergoing the discontinuous changes of properties which characterize formation of a new phase.

If, on the other hand, it be assumed that there remains unaltered, during the formation of solid solutions, some property of the liquid metals other than their "amorphousness," the quantitative relation between the observed and the extrapolated values of electrical resistance may be accounted for in a manner exactly analogous to that just discussed, while at the same time the highly improbable implications of this extension of the hypothesis of amorphous metals is avoided. The property retained might, for example, be a purely chemical (electronic) characteristic, and the chemical forces active in the solid solution might be the cause of its cohesion and hardness.

Whatever may be its explanation, the quantitative relation to which Dr. Feild has called attention is exceedingly striking, and data which will show whether it obtains generally are much to be desired.

Princeton University,
Princeton, N. J. DONALD P. SMITH.

Contributions by Metallography to L'Art Nouveau

To the Editor of Chemical & Metallurgical Engineering

SIR:—Martin Seyt is right in calling attention to the interesting forms and tones revealed in his microphotographs of metals; but he is certainly wrong in taking the occasion to make public fun of modern art, and his error is in bad taste. What would Mr. Seyt think of an artist who might ridicule metallographic science, though ignorant of it?

What would you think if the editor of some art journal opened his pages to sneering criticisms of reputable scientific achievement?

Modern as well as ancient art can, fortunately, well stand the gibes of those who do not comprehend. The principles upon which they rest endure.

F. B. LEWIS.

Milford, Del.

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To the Editor of Chemical & Metallurgical Engineering

SIR:—Please accept my thanks for copy of the text of Mr. Lewis's communication. What disturbs me far more than his criticism is that he should imagine humor or the making of "public fun of modern art" to be found in my modest contribution. It was an attempt to establish the correlation of Science with Art, more particularly of metallography with painting and sculpture. If Mr. Lewis were familiar with the Dutch language I should recommend to his consideration the much more elaborate efforts in this direction carried out in Holland under the inspiration of my uncle and his collaborator, Adam Seyt and Mohr, of Schiedam.

MARTIN SEYT.

Pure Gum Shellac

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with the greatest interest the excellent article "Pure Gum Shellac," which appeared in your issue of Dec. 10. I am certain the author will allow me to say that in India the well-known letters "T.N." are usually taken as standing for the mark of the firm, well known in its day, which very largely established this grade. The firm in this case was that of Tularam Nataram, which shipped under the initials "T.N."

D. T. CHADWICK,
Indian Trade Commissioner.

Department of Commerce and Industry,
Government of India,
London, England.

German Potash Production and Prices

ACCORDING to the German Potash Syndicate the total production of actual potash (K_2O) for 1919 was 946,000 short tons, of which 264,000 tons were sold abroad, the remainder meeting about 41 per cent of home requirements. These figures are given in *Commerce Reports* for Feb. 11, 1920, in conjunction with a report from The Hague dated Jan. 4, 1920, relating to the potash situation in Germany.

New Increase in Potash Prices

The German potash board, with the assent of the Minister of Economics, has announced a further increase in the schedule of prices of potash for domestic consumption. This is the fourth time that the prices have been raised within a year. The new increase amounts to about 45 per cent. The new prices are about six times as high as the prices in force at the time the war began. The mine owners have for some time been making urgent representations that they be allowed to increase prices, on the ground that the constantly increasing cost of operation had rendered production unprofitable. The failure to export any considerable quantity of potash to the United States, where "dollar prices" might have been obtained, is believed to have been one of the considerations which led the board and the Government to authorize the new increase in domestic prices.

Expressed in terms of marks per American unit (which is 1 per cent of actual potash per short ton of material), the new prices of potash for domestic consumption are as shown in the accompanying table:

	Marks per Unit
Crushed carnalite, 9 to 12 per cent actual potash (K_2O)	4 64
Crushed crude salts, 12 to 15 per cent K_2O	5 45
Manure salts, 20 to 22 per cent K_2O	6 73
Manure salts, 30 to 32 per cent K_2O	7 55
Manure salts, 40 to 42 per cent K_2O	8 82
Muriate, 50 to 60 per cent K_2O	10 46
Muriate, 61 per cent K_2O	11 46
Sulphate of potash, 42 per cent K_2O	13 82

Effect on Prices to United States

There is every indication that the syndicate will base its prices for sales to the United States on market conditions in America rather than on the legally regulated maximum prices for consumption in Germany. Germany is so anxious to secure dollar exchange from sales in the United States that the possibility of dumping large amounts of potash in America at low prices seems rather remote at present, especially in view of the fact that present production is far below normal.

Labor Conditions

Since the conclusion of the general wage agreements in July, 1919, labor conditions in the potash mines appear to have been fairly quiet. It is a well-known fact, however, that the productivity of individual laborers is very much diminished. The underground working day is now 7½ hr. instead of 9, as formerly, and the surface working day is 8 hr. in place of 10. One mine owner estimates that the daily individual productivity is now about 50 per cent of what it was before the war; another places the figure at 66 per cent. The factors which are holding back production at present, however, are inadequate housing facilities for workmen at some of the works, and fuel shortage. The latter factor is by far the more important.

In the last week of October it was reported that of the 210 potash works in Germany no less than 120 were lying idle on acocunt of lack of fuel; on Nov. 12 it was reported that 125 were idle.

Outlook of the Potash Industry

The potash syndicate's monopoly over reports from Germany has been left intact in the new legislation providing for the socialization of the industry. Apparently the syndicate is to have a free hand in the matter of dealing with the new situation which has been created by the loss of the Alsatian group of mines. The only present legal limitation over the syndicate's export activities is contained in section 87 of the new potash socialization law of July 19, 1919, which provides that prices for foreign sales may not be below the maximum domestic price.

Under the present circumstance of the heavy demand for German potash in various countries where the mark is at a great discount the syndicate has, of course, no inclination to charge lower prices for export than are charged for domestic sales. It is impossible to predict what kind of a readjustment will take place when the output of the Alsatian mines has increased so that French potash becomes an important factor in world trade, and when the supply of potash approaches the point of meeting the world demand. It does not seem improbable that attempts will then be made to form an international trust which might prove advantageous for the German as well as the French potash industry.

Hoover Awarded Civic Forum Medal

Herbert Hoover was awarded the Civic Forum's Gold Medal of Honor for Distinguished Public Service at a national testimonial in Carnegie Hall, New York, Feb. 18. The presentation was made by the Hon. Charles Evans Hughes, who stated that Mr. Hoover had created for the United States among European nations a reputation which "even the mistakes of diplomacy cannot obscure." Addresses were made by Ray Lyman Wilbur, president of Leland Stanford University; Horace V. Winchell, retiring president of the American Institute of Mining and Metallurgical Engineers; Dr. Aurelia Reinhardt, president of Mills College for Women, and the Hon. Henry Morgenthau, former Ambassador to Turkey. Mr. Hoover responded in a short speech in which he accepted the medal as trustee for the "great American army of volunteer workers and givers of which I was merely the instrument." The award of the medal may be considered a signal honor, the only former recipients being General George W. Goethals, Thomas A. Edison and Dr. Alexander Graham Bell.

Liquidation of Suspended Government Contracts

The Chemical Warfare Service has liquidated 94 per cent of the uncompleted portions of suspended contracts. These suspended contracts aggregated $38,828,000. The settlement payment was $5,197,000. The Nitrate Division of the War Department has liquidated 98 per cent of its suspended contracts, which totaled $9,090,000. The settlement payment was $1,527,000.

Only 48 per cent of the Ordnance Department contracts have been liquidated. These contracts, however, reached the enormous total of $2,040,288,000. To date, settlement payments aggregating $135,040,000 have been paid.

Prominent Chemists Lecture at West Point and Annapolis

In recognition of the increasing importance of chemistry in modern warfare, the Secretaries of War and the Navy requested the American Chemical Society to designate certain of their members to address the students of the Military and Naval Academies on matters relating to chemistry in warfare and chemical engineering.

The lectures are given under the general direction of the professors of chemistry at the two academies and are intended to supplement the regular courses in chemistry. The appointment of the speakers has been in the hands of Dr. William H. Nichols.

The West Point cadets have already heard talks by Dr. Charles L. Reese on the manufacture of explosives; Dr. William H. Walker on "The Manufacturing Problems of Gas Warfare"; Dr. Charles L. Parsons on "Nitrogen Fixation and Its Relation to Warfare"; Dr. Henry Fay on "The Amorphous State in Metals."

At Annapolis, the following chemists have addressed the students: Dr. William H. Nichols on "Sulphuric Acid—the Pig Iron of Chemistry"; Dr. John Johnson on "The Utilization of Research"; Dr. Arthur D. Little on "Natural Resources in Their Relation to Military Supplies"; Dr. Willis R. Whitney on "Industrial Research."

Other important lectures are to be given at both institutions this year.

Grants for Research by the American Association for the Advancement of Science

The American Association for the Advancement of Science has made a grant of $350 to Dr. Gerald L. Wendt, of the University of Chicago, for the investigation of the photochemical reactions of hydrogen and chlorine. Dr. Wendt has been able to show that under the action of alpha rays and in the vacuum discharge tube hydrogen assumes a form very active chemically, which probably has the formula H_3. From a valence point of view the existence—and even more so the properties and the method of formation—of this gas are of great interest. There is some evidence that chlorine is also activated by exposure to light, but the evidence is contradictory. The mechanism of the effect of ultra-violet radiation on chlorine, including the possibility of the existence of an ozone form of chlorine, will be investigated.

The following grants have also been made for research in physics:

To Prof. A. L. Foley, of Indiana University, $150 for experiments on the speed of sound very close to the source. This investigation is in extension of the important and rather remarkable results which Prof. Foley has recently published in the *Physical Review*.

To Prof. Orin Tugman, of the University of Utah, $100 to meet the cost of a monochromatic source of light to be used in finding the change of conductivity in a thin metallic film when exposed to ultra-violet light —a problem which has acquired new importance in view of the rapidly developing electronic theory.

To Prof. E. M. Terry, of the University of Wisconsin, $150 for work on the modulation of radio-energy employed in wireless telephony.

To Prof. F. C. Blake, of the Ohio State University, $100 for aid in prosecution of a study of electric waves and dielectric constants.

New Plan for Educational-Industrial Co-operation

Realizing that technical schools are not serving to a maximum degree the industrial market to which they owe their existence, the Technology Clubs Associated, through their president, have called a meeting at Drexel Institute, in Philadelphia, on March 25, 26, and 27.

Dr. Hollis Godfrey is now president of the combined Technology Clubs Associated. As chairman of the Engineering-Education Section of the Council of National Defense during the period of the war, he foresaw the alarming shortage of trained men. He saw that there was much waste in present technical education and that to eliminate this waste, industry must be called upon to specify exactly what it requires of the graduating engineer.

A number of industries which saw the need for betterment each contributed $2,500 to carry on the study, and besides gave much of the time of their executives. Educators who were also engineers were sent out into the industry. They made a study of manufacturing processes to determine what knowledge was essential if men were to be successful in the various fields. Their findings and the suggestions of the representatives of plants visited were submitted to a board of educational experts who outlined courses and formulated plans to meet the industrial demand with the possible educational supply.

First Plant to Locate at Nitro

The Director of Sales announces that the first commercial industry to locate at Nitro, W. Va., the War Department's "smokeless powder city," will result from the purchase by the Central Foundry & Supply Co. of Columbus, Ohio, of a factory site from the Charleston Industrial Corp. of Charleston, W. Va. The sale has been approved by the Ordnance Salvage Board and the Director of Sales, in accordance with a contract under which the Government sold Nitro to the Charleston Corp. last December.

The "smokeless powder city" site which was selected by the Central Foundry & Supply Co. consisted of five and one-half acres of land and contained such buildings as a sheet metal shop, a brass and iron foundry, a pipe and electric shop, a welding shop and numerous smaller structures. The purchasers will establish a branch plant at Nitro.

Government Needs Chemists and Other Technical Men

The United States Civil Service Commission announces that the Government service is in need of a large number of chemists. During this period of readjustment, technical men are especially needed. Besides chemists, it is stated that there are openings for physicists, ceramic assistants, laboratory assistants and aids; metallurgical, technical and electrical laboratorians, etc. Further information and application blanks may be obtained from the secretary of the U. S. Civil Service Board at Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle or San Francisco, or from the U. S. Civil Service Commission, Washington, D. C.

Disposal of Government Sulphuric Acid

Sulphuric acid to the extent of 1,832,000 lb., declared surplus by the Ordnance Salvage Board, has been sold to the General Chemical Co. of New York.

New York Meeting of the American Institute of Mining Engineers

Report of Annual Meeting at Which Herbert C. Hoover Was Elected President — Institute Approves Joint Conference Committee Report for National Association of Engineers— Simplified Spelling Killed—Report of Technical Sessions

THE annual meeting of the American Institute of Mining and Metallurgical Engineers was held at Institute headquarters in New York, Feb. 16 to 19 inclusive. The business meeting was held Tuesday morning, at which announcement was made of the election of Herbert C. Hoover to be president of the Institute for the ensuing year. Mr. Hoover's presidential address, which was delivered at the banquet, is published elsewhere in this issue.

An effort made by a few enthusiasts to foist simplified spelling on the Institute was decisively defeated, and it is presumed that this matter has finally been killed and that the membership will not again be called upon to waste time in its consideration.

An amendment to the constitution was adopted raising the annual dues from $12 to $15.

The most important matter considered at the meeting on Tuesday morning was the report of the Joint Conference Committee appointed last year to consider, with representatives of the other national engineering societies, a plan to unite all engineers with respect to their civic and public relations. This joint conference report had already been approved by two of the four national societies and is now being considered by the third. The principle involved is the amalgamation of not only the four national societies but of all local and regional societies in the United States into a representative engineering body. It is intended that this body shall be empowered to act for the engineering professions in the United States as far as concerns relations with the public and the Government.

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The report of the Joint Conference Committee was made by Prof. J. W. Richards, who said in part: "The Joint Conference Committee believes that the greatest value of the proposed organization is in the united effort for the service of the nation, from which effort will result the greatest service to the individual. The committee submits the plan in the confident belief that it will be accepted by the four societies; that they will assume the responsibility of leadership, supporting the movement by virtue of their position in the engineering profession. The following movement by local societies is sure to come. Several attempts have been made to organize such a representative body by other agencies than these four engineering societies. There is one society in particular, the American Association of Engineers, which very actively wishes to assume the leadership in this kind of an organization. If the engineering societies do not take this leadership, it will drive it into the hands of those whom we all believe are less qualified to direct it and to lead it. The four national societies can take the initiative and continue their leadership in American engineering by prompt action, or, by inaction, lose the prestige they now hold."

J. Parke Channing, chairman of Engineering Council, urged the adoption of the report, saying: "A thing that has hampered us has been the feeling all over the country that we were not truly representative; that we represented only the four founder societies and the Society for Testing Materials. If we can have what we may term a larger Engineering Council we will better represent the engineering profession and have a better backing."

After further discussion the motion to approve the principles of the report of the Joint Conference Committee was adopted unanimously.

The plan calls for an organization with the following objects:

1. To render the maximum of service to the nation through unity of action.
2. To give the engineers of the country a more potent voice in public affairs.
3. To secure greater recognition of the services of the engineer and to provide for his advancement.
4. To promote *esprit de corps* among the members of the profession.
5. To provide the machinery for prompt and united action on matters affecting the profession, among which are: Licensing and registration of engineers; National Service Committee; National Department of Public Works; conservation of national resources; publicity; classification and compensation of engineers; general employment bureau; engineering education; international affiliation of engineers; industrial relations.

The Smoker

The smoker was a most enjoyable affair. W. L. Saunders presided as ringmaster and made some humorous references to the fact that this was the first dry smoker the Institute had ever attempted to hold. The committee in charge had nevertheless arranged

for some unusual features to offset the lack of the usual refreshment.

First on the program came Major R. Deere, Fellow of the Royal Hypothetical and Hieroglyphical Society and Inspector General of Nurseries for War Babies. The Major announced during the war it became necessary to discover new tin deposits and that a careful search was made in the Province of Ontario, Canada. The selection of a suitable place for prospecting was arrived at mathematically, using the atomic weights of silver which occurred at Cobalt, gold at Porcupine, nickel at Sudbury and copper in Michigan. A special instrument known as the stanniphone was devised to assist in the search of tin. The peculiar characteristic of this device is that when it is manipulated like a divining rod it reproduces the "cry" of tin. The Major showed a geographical map to illustrate just how effectively the stanniphone had functioned. Another feature of the smoker was a modification of the well-known badger fight in which the dupe pulled Mr. Hoover's hat into the ring. The screen was used for films on mining methods at Chuquicamata, Chile, as well as for reproducing some of the unusual ballots on the simplified spelling proposition. Other entertainment was furnished by a quartet and a magician who mystified with tricks and mind reading.

Banquet

The banquet on Tuesday evening was made the occasion for the retiring address of Mr. Winchell and the inaugural speech of Mr. Hoover. Wit and humor characterized the speeches of Toastmaster Lawrence Addicks, who drew repeated rounds of laughter from the audience at the expense of the speakers whom he introduced. The prospect of having a future banquet otherwise than dry was held by him to be improbable in view of the fact that the new president of the Institute spells his name H$_2$Over.

Retiring President Winchell reviewed the work of the Institute during the past year and emphasized the fact that civic responsibilities must be more largely assumed by engineers. Mr. Hoover's speech, which is printed elsewhere in this issue, practically comprised a statement of governmental policy with regard to railroads, shipping, and industrial relations.

The speeches of the evening were closed by Dr. James F. Kemp, who was created by Mr. Addicks a member of the Order of the Golden Fleece. Dr. Kemp sped the parting and welcomed the coming president in a most pleasing manner.

There was a large attendance of ladies at the Institute meeting and the customary entertainment of luncheons, teas and theater parties was carried out.

Excursion to Bush Terminal

On Thursday the members were taken to the Bush Terminal in Brooklyn, which is the largest port and warehouse development at any harbor in the world. It covers two hundred acres of ground, has thirty miles of railroad track, has modern steamship piers, each over a quarter of a mile long, at which thirty-five steamships can load or unload at the same time.

The plant includes 122 warehouses, fifteen model loft buildings, containing more than 5,000,000 sq.ft. of space, a million-dollar eight-story reinforced concrete service building, equipped with every modern convenience to handle merchandise, and a coal storage plant of scientific type with 1,500,000 cu.ft. of coal storage space.

Metallurgical Sessions

Non-Ferrous Metallurgy

While but three papers were presented at the Institute of Metals division, they were of great interest to those attending, resulting in a very lively discussion of each. Particularly F. L. Antisell's paper on the "Relationship of Physical and Chemical Properties of Copper" was acclaimed as an informative contribution, especially to the user of electrolytic copper.

Mr. Antisell emphasized that it is much simpler to produce from a refining furnace copper shapes which are metallurgically correct than those that are mechanically satisfactory. Evidently extreme care must be taken with metal cast in an open chill-mold if it is to be rolled or drawn into the thinnest sheet or finest wire without exhibiting any surface defects. After briefly discussing the terms "pitch" and "set," and describing the well known action of copper oxide in metal and particularly its detection by fracture and pitch, the author says:

"Unhealthy copper contains slight quantities of gases, such as hydrogen, carbon monoxide, sulphur dioxide, and carbon dioxide. If an attempt is made to remove the excessive oxygen, the copper will spew; that is, a miniature volcanic action will occur in the shape and the copper will be known as overpoled. Copper in this state will be low in electrical conductivity and have a small reduction in area, due to several reasons, particularly the excess of oxygen. These properties can be improved only by subjecting the entire charge to a refining process, which consists of oxidizing the copper, thus removing the reducing gases, and then poling the copper up to a tough pitch. Unhealthy copper may present either a high or a low pitch, but if an attempt is made to raise the low pitch, the copper will spew.

"Reasons for rejecting refined copper on physical examination are: Low pitch; overpoling; cold sets; spewing; shot; fish (slivers of foreign copper, as the fins from the pouring ladle, etc.); holes of several characters, as water holes, shake holes, shrink holes, gas holes, spew holes, general porosity; foreign substances, such as charcoal, bone ash, dirt, etc.; splashes; fins; cracks; large set marks; water bursts; ridges on surface; shapes cast in rough molds; wrong dimensions; and collective defects. By the last term are meant two or more slightly developed defects, one of which would not be a sufficient cause for the rejection of the shape."

Causes for each of these troubles are then mentioned briefly, particularly with reference to their relation to the modern practice of casting in a traveling series of molds. Electrical conductivity, of course, is a most important test for finished copper; this when supplemented by a bending test on a Capp machine will usually give about all the necessary information desirable for acceptances. The author particularly recommended the bending test as simple and very reliable; however, high arsenic will not be detected by it, but this element is quickly noticed in the conductivity measurements.

"A few general laws may be stated for the tough-pitch period, with reference to the relative properties of copper, which are applicable over a short range only:

"1. As the tensile strength increases, the conductivity decreases.

"2. As the oxygen contents increase, the tensile strength increases.

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"3. As the tensile strength increases, the elongation decreases.

"4. As the oxygen contents increase, the resistance of bending decreases."

Discussion

In the discussion Mr. CAESAR emphasized the importance of annealing practice, too often neglected by the manufacturer of rolled or drawn products. For copper, 700 deg. C. is the limit of temperature without endangering the ductility, which heating, by the way, should be done with an oxidizing condition in the furnace.

Prof. A. L. WALKER described some early troubles with mechanical casting. For instance, considerable trouble was experienced with otherwise quite satisfactory wire bars having a crack on their under side in the region where the stream of hot metal was poured into the mold. After much study, it appeared that this location stayed liquid longest in the solidifying bar, finally setting considerably later than the ends. Since the intercrystalline cement in copper is very brittle just below the freezing point, the region in question was unable to draw in the solidified ends, and a shrinkage crack resulted, a condition often observed in many metals after slow cooling. The trouble was obviated in this case by moving the pouring stream from end to end of the open mold.

W. R. WEBSTER, however, felt that the above defect was but another confirmation of his growing idea that the standards of performance of copper refiners now are not as high as they were twenty-five years ago. This probably was an unconscious drift, but doubtless was due to the difference between well-done hand work by skillful refiners and carelessly done machine work where quantity was unduly emphasized. For instance, in the old days the Bridgeport brass companies' record charge would be about 40,000 lb., and he felt that the small furnaces then in vogue were much more easily controlled than the huge furnaces now in operation. F. R. PYNE took sharp issue with this idea, saying that since in the old days plates and staybolts were the principal outlet for pure copper products, toughness and strength were the prime considerations. Now, however, copper is made with an eye toward its electrical properties; as a result it is controlled so completely as to its arsenic, silver and oxygen contents that it actually is too pure to suit some manufacturing processes. Aluminum apparently is another whose best properties are had with somewhat impure metal.

Intercrystalline Brittleness

Two papers on intercrystalline brittleness of lead and of copper were presented by H. S. RAWDON in collaboration with S. C. LANGDON. It appears that much lead sheathing used to protect aerial and subterranean feederlines on electric systems is subject to a crumbling deterioration, giving spots so weak and brittle that it could be easily crumbled into a gray powder. Each particle when pressed with a pestle appeared quite malleable and, when cut, gave the characteristic color and luster of lead. Microscopic examination of a portion in which the metal was only partly embrittled showed that the method of the corrosive attack is intercrystalline in its nature, and that the action begins on the exposed surface of the sheathing and proceeds inwardly was very evident. A chemical analysis of the material showed that there was no essential difference between the corroded and the uncorroded parts and that the lead contained a considerable amount of tin.

Since the melting point of the granules was within 0.2 deg. C. of the sound portion, it was concluded that allotropy was not present. In fact, specimens of very pure lead were treated in the manner described by previous investigators for the production of the allotropic form of lead. No evidence was obtained to justify the claim that lead may exist in an allotropic state analogous to the well-known gray tin. The forms of lead previously described in the scientific literature as allotropic states appear to be due to an intercrystalline attack by the electrolyte, immersion in which was necessary to bring about the allotropic change. The rate at which the so-called allotropic transformation occurs is largely a function of the purity of the lead and the acidity of the electrolyte in which the metal is immersed.

From these experiments, and others exhibiting the mechanism of etching agent attack, Dr. RAWDON concludes that the difference in solubility of the impurities (which are substantially all insoluble in the solid, and therefore form eutectiferous cementing films) and of the pure lead comprising the interior of the crystal accounts largely for the disintegration of the metal by intercrystalline embrittlement when immersed in a weak acid solution consisting of substances leached out of the surrounding concrete. The greater rate of disintegration of commercial lead, as compared with pure lead, is due to the larger amount of these intercrystalline impurities.

In the short paper on copper, RAWDON and LANGDON determine the cause of embrittling when ductile bars are cleaned in molten salt. During this time they had been in contact with iron, thus forming a galvanic cell of which copper was the cathode. Metallic sodium was then deposited from the fused electrolyte, which immediately alloys with the copper. The most striking feature is the selective attack by which the metal at the grain boundaries is acted upon and the action progresses inwardly between the crystals instead of forming an alloy layer upon the outside of uniform thickness. The behavior of a specimen showing under the microscope but a thin penetration by the sodium, when subjected to the bend test illustrates the effect of a relatively thin brittle skin upon the properties of a much larger piece. The structure of the interior of the specimen showed no evidence of brittleness any more than did that of the rod used as an anode, or the rod in its initial state. It may be assumed, therefore, that only a relatively very thin skin has been rendered brittle by the electrolytic action, yet the properties of the entire rod have been very profoundly changed.

Discussion

T. D. YENSEN called attention to this latest variety of copper brittleness in comparison to a similar effect of hydrogen, occluded at the cathode or elsewhere. As he has shown with N. B. PILLING, in this case hydrogen enters into the copper very readily, but reacting with the oxide in the eutectic areas, forms water which diffuses outward very slowly.

G. H. CLAMER and F. A. HALL also pointed out the very annoying and expensive failures of bearing liners, which had not yet been adequately studied. These liners, which may be either pure lead or lead alloyed with antimony and tin, are turned and soldered to a backing. After more or less service they crack away

at the tinned joint, and if they fall out of a journal without the fact being noticed, hot boxes are sure to result. The same phenomenon gave some trouble with aircraft motors. The connecting rod bearings were bronze shells with babbitt linings. A preliminary study of this indicated intercrystalline fracture, but Mr. HALL was unable to pursue the study to a successful conclusion.

ZAY JEFFRIES pointed out that much brittleness in even purest metal was due to the entirely different physical properties of the crystalline grains and the amorphous cementing material, citing Rosenhain and Archbutt's recent results on season cracking of brass, wherein they show that such is an intercrystalline break due to the amorphous materials' entirely different rate of deformation under applied load than that of the grain metal. A similar effect has been shown by Merica to take place in the β-brass boundaries of α grains. Lead of great purity can be broken at the grain boundaries after long exposure to moderate loads; the amorphous phase apparently is viscous, deforming slowly like pitch, while the crystalline phase is non-viscous but elastic, deforming under load quickly to a definite point. Boiler tubes stressed and at 300 to 400 deg. C. acquire great brittleness for the same reasons: in fact Dr. Jeffries believes that much brittleness can only be explained by a difference of specific properties, amorphous to crystalline phase, usually accentuated at high temperatures and especially evident under slow loadings.

MILLING AND SMELTING

FREDERICK P. DEWEY presented an exhaustive paper on "Volatilization in Assaying" which we hope to publish in full in the near future. Starting from the common excuse of poor results that volatilization is to blame, he discusses the general effect of vaporization in cupellation, the loss through dusting, the relation of vapor pressure and volatility, the condensation of muffle fumes, and then passes on to a review of the literature on volatility of gold, silver and lead, both pure and alloyed and as affected by oxygen in solution, each section of which is amplified by observations from the author's unexcelled practice. In the end he is forced to the conclusion that there is no real evidence that in a properly conducted assay, the loss of either gold or silver by volatilization is sufficient to affect appreciably the result, even when arsenic or antimony may be present.

DISCUSSION

J. W. RICHARDS, in discussion, observed that theoretical deductions from vapor pressure curves were often unsubstantiated in practice simply because losses by "misting" were very important—that is, the true vapor carries with it a cloud of minute globules of liquid metal, whose quantity has no simple relation to the boiling point. The author, however, emphatically disputed the purely theoretical conclusion that all solid metals had a vapor pressure greater than zero.

COAL-PULVERIZING PLANT AT NEVADA CONSOLIDATED SMELTER

A detailed description of a dust-firing system was given by R. E. H. POMEROY in a paper entitled "Coal-Pulverizing Plant at Nevada Consolidated Smelter." The plant itself replaced an oil-storage system and contains many innovations suggested by the smelter staff, and has operated over a year with entire satisfaction and very little repair replacements.

The principal advantages of the system, which influenced this decision, were: (1) Equal safety; no pulverized coal is stored at the furnaces; (2) greater ease of operation, furnace fires being controlled by regulating valves in burner branches, as in gas firing; (3) better organization; all machinery, including pulverized coal feed, is under one roof, and the organization is separate from the furnace department; (4) greater cleanliness; all machinery is under vacuum and the building is automatically ventilated. (5) greater flexibility of application; the coal and air mixture can be piped where needed.

As is perhaps well known, this system works on a closed circuit and involves the transportation of pulverized coal as a suspension in air, the quantity of coal required at any furnace being withdrawn by appropriate connections, and any unconsumed coal, amounting to from 10 to 100 per cent of the supply, may be returned to the grinding plant by a separate main. The paper contains a well-made flow sheet showing each piece of apparatus in its proper location.

DISCUSSION

In discussion, B. F. TILLSON called attention to the fact that certain data, essential to the designer of such piping systems, appeared to be very hard to find. For instance, what is the friction of a stream of air carrying coal? What is the best proportion of air to coal? What is the minimum velocity which will carry, say, 200-mesh coal? Mr. TILLSON also was puzzled to know why flare-backs at the nozzles are not continually occurring. It appears that if all the 2-in. head often used were translated into velocity head, the speed of the combustible mixture would amount to about 8,000 ft. per min., yet the Bureau of Mines states that the minimum velocity of propagation of explosion in coal dust is 200 ft. per sec. and rapidly approaches a velocity ten times as high.

TREATING CONVERTER SLAG

A paper by FREDERICK LAIST and H. J. MAGUIRE on "Reverberatory Furnace for Treating Converter Slag at Anaconda" has already been abstracted in CHEMICAL & METALLURGICAL ENGINEERING, Feb. 4, 1920, p. 231. The chairman, E. P. MATHEWSON, said that this large furnace was constructed with no little trepidation. However, it was structurally excellent, and operated very nearly as predicted after the first few starting troubles had been overcome. The new furnace added far more than its allowable quota to the smoke in the converter building, while some adjustment was necessary before the correct location of the slag inlet was found.

C. G. MAIER emphasized his ideas already developed that in order to recover copper from slags the quantity of contained Fe_3O_4 must be reduced. Otherwise it will oxidize sulphur from the globules of trapped sulphides, forming bubbles of SO_2 gas, which act as a balloon, buoying up the particle.

W. C. SMITH observed that he had examined slags from the Tennessee Copper Co., which substantiated Maier and Van Arsdale's conclusions. Blast furnaces working on green ore showed no magnetite; slag from a matte-concentrating furnace contained but very little magnetite; converter slag, however, was loaded with Fe_3O_4 and overflow from a settler to which molten con-

[1] *Eng. & Mining J.*, May 10, 1919, vol. 107, p. 815; CHEM. & MET. ENG., July 1, 1919, vol. 21, p. 46.

verter slag had been added had nearly as much magnetite as the original converter slag. Mr. Smith had run several series of successive charges of converter slag plus 14 per cent coke into an ordinary blast furnace in regular operation, at the same time sampling the slag at frequent intervals, but no increase in the amount of cementite could be discovered.

E. E. THUM called attention to the diversity of practice in regard to the handling of converter slag at the large Western plants, and pleaded for an analysis of the smelterman's ideas in the light of Maier and Van Arsdale's researches. Many plants cast their converter slag in a more or less expensive manner, using machines of various degrees of excellency, for subsequent resmelting in a blast furnace. Other metallurgists were content to add the slag to a reverberatory furnace; some in the solid state, others insisting that it be poured in with a very considerable drop. It is, in fact, contended that a reverberatory will recover copper from concverter slag if its iron content be low enough, but unfortunately some ore supplies will not allow a close limitation of this element.

MILLING PLANT OF THE ALASKA-GASTINEAU MINING CO.

E. V. DAVELER's paper on the "Milling Plant of the Alaska-Gastineau Mining Co." appears in full on page 361 of this issue. The most noticeable innovation was the use of skip-hoists in place of belt-elevators, and this feature was commented upon in the discussion. W. L. RENICK, a member of the operating staff, stated that these skips were very discouraging at first, requiring two men on each to approach a semblance of operation. A flat cable was used, so that the speed of skip travel rapidly changed even when the driving motor was running uniformly, but unfortunately the blow at the bottom and top stop could not be regulated. This meant trouble with stopping at the correct place, and more trouble with bin gates opening and filling hoist pit with ore. However, as soon as the dash-pot described was hit upon, the problem was solved so satisfactorily that the staff would not think of replacing this automatic equipment with the old-style bucket elevators.

The discussions on Iron and Steel will be presented in this journal for March 3, 1920.

Elimination of Dust Hazard at Niagara Falls Plant

A survey of the chemical and metallurgical plants at Niagara Falls by the United States Public Health Service brought forth the fact that the health of the workers in many of the factories was endangered by the presence of innumerable fine particles of dust in the air. Once breathed into the lungs, such particles are never expelled. Photomicrographs show the tiny particles to be exceedingly sharp and jagged and chemical tests prove them to be practically insoluble.

In all of the factories the laborers were found to be exposed to dangers which would eventually incapacitate them for further work. Fortunately over 60 per cent of the labor in these plants seeks new employment monthly and the result of exposure to such dangers is not as evident as it would be if the workers remained at the same work for longer periods.

As a result of the survey industrial hygiene engineers devised means of removing the dust from the air and minimizing hazards from fumes and poisonous gases. In spite of the fact that the installation of such devices was expensive, factory managements immediately put them into use.

Imports and Exports

The Department of Commerce reports for December, 1919:

DOMESTIC EXPORTS FROM THE U. S. BY COUNTRIES

Countries	Caustic Soda — Lb.	Caustic Soda — Value	Soda Ash — Lb.	Soda Ash — Value
Denmark	784,299	$22,330	.....	.....
France	7,760	2,077	.....	.....
Greece	22,800	800	.....	.....
Italy	630,880	21,777	.....	.....
Spain	339,433	30,773	.....	.....
Canada	691,619	25,489	2,860,936	$81,132
Costa Rica	6,900	250	.....	.....
Honduras	3,480	135	8,823	227
Nicaragua	30,950	1,069	.....	.....
Salvador	7,600	360	.....	.....
Mexico	155,133	5,719	42,955	1,175
Jamaica	12,938	519	3,750	50
Cuba	624,672	16,172	141,900	2,834
Haiti	20,040	672	.....	.....
Dominican Republic	14,375	498	3,600	90
Argentina	34,378	1,519	.....	.....
Brazil	451,330	22,515	11,040	259
Chile	45,992	2,204	.....	.....
Colombia	58,011	2,190	26,500	835
Ecuador	20	1	.....	.....
British Guiana	1,000	60	.....	.....
Peru	4,240	195	.....	.....
Uruguay	2,208	85	.....	.....
Venezuela	23,443	803	12,591	397
China	115,504	3,469	300	6
Japanese China	89,654	3,586	.....	.....
British India	58,250	1,850	5,600	135
Dutch East Indies	64,792	2,592	3,000	61
Japan	6,358,922	229,273	1,050,208	20,531
Philippine Islands	2,800	77	.....	.....
British South Africa	4,467	195	.....	.....
Total	10,667,890	$399,254	4,171,203	$107,732

DOMESTIC EXPORTS FROM THE U. S. BY COUNTRIES—IMPORTS INTO THE U. S. BY TOTALS

Countries	Glycerine Lb.	Glycerine Value	Countries	Glycerine Lb.	Glycerine Value
Azores and Madeira Is.	100	$28	China	87	24
Greece	1,625	409	British India	2,570	704
Spain	2,845	627	Dutch East Indies	50	12
Canada	1,168	234	French East Indies	400	120
Costa Rica	576	131	Hong Kong	7,150	1,840
Nicaragua	160	55	Japan	71,100	15,792
Mexico	11,404	2,093	Philippine Islands	60	15
Trinidad and Tobago	50	13	British South Africa	500	115
Cuba	6,610	1,461	Egypt	2,000	436
Haiti	50	15			
Argentina	2,550	762	Total	129,597	$30,060
Brazil	1,227	314			
Chile	14,100	3,489	IMPORTS		
Colombia	1,245	862		Lb.	Value
Peru	1,395	370			
Venezuela	575	139	Total	607,408	$54,567

German Opinion of Chemical Foundation

In a recent bulletin issued by the Chemical Foundation to its stockholders and licensees, attention is called to an article on "The Chemical Foundation and Its Aims," which appeared in *Die Chemische Industrie*, vol. 42, p. 186, August, 1919. A literal translation of the article is included in the bulletin.

The German critic has been impressed with the idea that the stock of the Foundation is to be as widely distributed as possible, and that each stockholder is to be allowed only two shares of voting stock. He is further impressed with the fact that the patents of the Foundation are open only to those manufacturers who can prove their Americanism as well as to show adequate technical qualifications. He carefully calls attention by the use of italics to the fact that as many of the patents owned by the Foundation are *product* patents, the Foundation should be able to exclude importations *as a matter of course*. In conclusion it is stated that *"the further development of the Chemical Foundation must at any rate be watched very closely in Germany. In truth this company represents the shrewdest militant organization that thus far has been formed abroad against the German chemical industry. Neither legal nor moral scruples concerning the inconsiderate action previously taken against guaranteed private property appear to have occurred to the founders of this company, for whom the principle 'Right or Wrong, My Country' apparently has exclusive prevalence in peace times as well."*

The Engineer in National Affairs

Presidential Address at the Annual Meeting of the American Institute of Mining and Metallurgical Engineers—Outline of a National Policy With Regard to Railroads, Shipping, and Industrial Relations—Need of Engineering Thinking in Government Administration

By HERBERT C. HOOVER

I HAVE been greatly honored as your unanimous choice for president of this Institute, with which I have been associated during my entire professional life. It is customary for your new president, on these occasions, to make some observation on matters of general interest from the engineer's standpoint.

The profession of engineering in the United States comprises not alone scientific advisers on industry, but is in great majority comprised of the men in administrative positions. In such positions they stand midway between capital and labor. The character of your training and experience leads you to exact and quantitative thought. This basis of training in a great group of Americans furnished a wonderful recruiting ground for service in these last years of tribulation. Many thousands of engineers were called into the Army, the Navy, and civilian service for the Government. Thousands of high offices were discharged by them with credit to the profession and the nation.

Engineers for Efficiency in Government

We have in this country probably one hundred thousand professional engineers. The events of the past few years have greatly stirred their interest in national problems. This has taken practical form in the maintenance of joint committees for discussion of these problems and support to a free advisory bureau in Washington. The engineers want nothing for themselves from Congress. They want efficiency in government, and you contribute to the maintenance of this bureau out of sheer idealism. This organization for consideration of national problems has had many subjects before it, and I propose to touch on some of them this evening.

Interdependence of World Affairs

Even more than ever before is there necessity for your continued interest in this vast complex of problems that must be met by our Government. We are faced with a new orientation of our country to world problems. We face a Europe still at war; still amid social revolutions; some of its peoples still slacking on production; millions starving; and therefore the safety of its civilization is still hanging by a slender thread. Every wind that blows carries to our shores an infection of social disease from this great ferment; every convulsion there has an economic reaction upon our own people. If we needed further proof of the interdependence of the world, we have it today in the practical blockade of our export market. The world is asking us to ratify long-delayed peace in the hope that such confidence will be restored as will enable her to reconstruct her economic life. We are today contemplating maintenance of an enlarged Army and Navy in preparedness for further upheavals in the world and failing to even provide some insurance against war by a league to promote peace.

Some of Today's Problems

Out of the strain of war, weaknesses have become even more evident in our administrative organization, in our legislative machinery. Our Federal Government is still overcentralized, for we have upon the hands of our Government enormous industrial activities which have yet to be demobilized. We are swamped with debt and burdened with taxation. Credit is woefully inflated; speculation and waste are rampant. Our own productivity is decreasing. Our industrial population is crying for remedies for the increasing cost of living and aspiring to better conditions of life and labor. But, beyond all this, great hopes and aspirations are abroad; great moral and social forces have been stimulated by the war and will not be quieted by the ratification of peace. These are but some part of the problems with which we must deal. I have no fear that our people shall not find solutions; but progress is sometimes like the old-fashioned rail fence—some rails are perhaps misshapen, and all look to point the wrong way; but in the end, the fence progresses.

Objections to Government Control

Your committees, jointly with those of other engineering societies, have had before them and expressed their views in many matters concerning the handling of the railways, shipping, the reorganization of the Government engineering work, the national budget, and other practical items.

The war nationalization of railways and shipping are our two greatest problems in Government control awaiting demobilization. There are many fundamental objections to continuation of these experiments in socialism necessitated by the war. They lie chiefly in their destruction of initiative in our people and the dangers of political domination that can grow from governmental operation. Beyond this, the engineers will hold that the successful conduct of great industries is to a transcendent degree dependent upon the personal abilities and character of their employees and staff.

Competition and Efficient Schooling

No scheme of political appointment has ever yet been devised that will replace competition in its selection of ability and character. Both shipping and railways have today the advantage of many skilled personnel, sifted out in the hard school of competition, and even then the Government operation of these enterprises is not proving satisfactory. Therefore, the ultimate inefficiency that would arise from the deadening paralysis of bureaucracy has not yet had full opportunity for development. Already, we can show that no government, under pressure of ever-present

political or sectional interests, can properly conduct the risks of extension and improvement or can be free from local pressure to conduct unwarranted service in industrial enterprise. On the other hand, our people have long since recognized that we cannot turn monopoly over to unrestrained operation for profit or that the human rights of employees can ever be dominated by dividends.

Need of Increased Transportation Facilities

Our business is handicapped on every side by the failure of our transportation facilities to grow with the country. It is useless to talk about increased production to meet an increased standard of living in an increasing population without a greatly increased transport equipment. Moreover, there are very great social problems underlying our transport system. Today their contraction is forcing a congestion of our population around the great cities, with all that these overswollen settlements import. Even such great disturbances as the coal strike have a minor root in our inadequate transportation facilities and their responsibility for intermittent operation of the mines.

We are all hoping that Congress will find a solution to this problem that will be an advanced step toward the combined stimulation of the initiative of the owners, the efficiency of operation, the enlistment of the good will of the employees, and the protection of the public. The problem is easy to state. Its solution is almost overwhelming in complexity. It must develop with experience, step by step—toward a real working partnership of its three elements.

The return of the railways to the owners places predominant private operation upon its final trial. If instant energy, courage, and large vision in the owners should prove lacking in meeting the immediate situation, we will be faced with a reaction that will drive the country to some other form of control. Energetic enlargement of equipment, better service, co-operation with employees, and the least possible advance in rates, together with freedom from political interest, will be the scales upon which the public will weigh these results.

Expansion of Shipping

Important phases of our shipping problem that have come before you should receive wider discussion by the country. As the result of war pressure, we will spend over $2,800,000,000 in the completion of a fleet of nineteen hundred ships, of a total of 11,000,000 tons—nearly one-quarter of the world's cargo shipping. We are proud of this great expansion of our marine, and we wish to retain it under the American flag. Our shipping problem has one large point of departure from the railway problem, for there is no element of natural monopoly. Anyone with a water-tight vehicle can enter upon the seas today, and our Government is now engaged upon the conduct of a nationalized industry in competition with our own people and all the world besides. While in the railways Government inefficiency could be passed on to the consumer, on the seas we will sooner or later find it translated to the national Treasury.

Private vs. Government Shipping Business

Until the present time, there has been a shortage in the world's shipping, but this is being rapidly overtaken, and we shall soon be met with fierce competition of private industry. If the Government continues in the shipping business, we shall be disappointed from the point of view of profits; for we shall be faced with the ability of private enterprise to make profits from the margins of higher cost of Government operation alone. Aside from those losses inherent in bureaucracy and political pressure, there are others special to this case. The largest successfully managed cargo fleet in the world comprises about one hundred and twenty ships, and yet we are attempting to manage nineteen hundred ships at the hands of a Government bureau. In normal times the question of profit or loss in a ship is measured by a few hundred tons of coal wasted, by a little extravagance in repairs, or by four or five days lost on a round trip. Beyond this, private shipping has a free hand to set up such give-and-take relationships with merchants all over the world as will provide sufficient cargo for all legs of a voyage, and these arrangements of co-operation cannot be created by Government employees without charge or danger of favoritism. Lest fault be found, our Government officials are unable to enter upon the detailed higgling in fixing rates required by every cargo and charter. Therefore, they must take refuge in rigid regulations and in fixed rates. In result, their competitors underbid by the smallest margins necessary to get the cargoes. The effect of our large fleet in the world's markets is thus to hold up rates, for so long as this great fleet on one hand holds a fixed rate others will only barely underbid. If we hold up rates, an increasing number of our ships will be idle as the private fleet grows. On the other hand, if we reduce rates we shall be underbid until the Government margin of larger operation cost causes us to lose money.

Problems of American Shipping Industry

We shall yet be faced with the question of demobilizing a considerable part of this fleet into private hands, or frankly acknowledging that we operate it for other reasons than interest on our investment. In this whole problem there are the most difficult considerations requiring the best business thought in the country. In the first instance, our national progress requires that we retain a large fleet under our flag to protect our national commercial expansion overseas. Secondly, we may find it desirable to hold a considerable Government fleet to build up trade routes in expansion of our trade, even at some loss in operation. Thirdly, in order to create this fleet, we have built up an enormous shipbuilding industry. Fifty per cent of the capacity of our shipyards will more than provide any necessary construction for American account. Therefore there is a need of obtaining foreign orders, or the reduction of capacity, or both. I believe, with most engineers, that, with our skill in repetition manufacture, we can compete with any shipbuilders in the world and maintain our American wage standards; but this repetition manufacture implies a constant flow of orders. It would seem highly desirable, in order to maintain the most efficient yards until they can establish themselves firmly in the world's industrial fabric, that the Government should continue to let some ship construction contracts to the lowest bidders, these contracts to supplement private building in such a way as to maintain the continuous operation of the most economical yards and the steady employment of our large number of skilled workers engaged therein.

When we consider giving orders for new ships, we must at the same time consider the sale of ships, as we cannot go on increasing this fleet. When we consider sale, we are confronted with the fact that our present

ships were built under expensive conditions of war, costing from three to four times per ton the pre-war amount, and that already any merchant, subject to the long time of delivery, can build a ship for 75 per cent of their cost. It would at least seem good national policy to sell ships today for the price we can contract for delivery a year or two hence, thus making the Government a reservoir for continuous construction. We could thus stabilize building industry to some degree and also bring the American-owned fleet into better balance, if, as the Government sold three or four emergency-constructed cargo vessels, it gave an order for one ship of a better and faster type. This would make reduction in our shipbuilding steadier and would give the country the type of ships we need.

Engineering Committees Recommend Remedies for Governmental Efficiency

Our joint engineering committees have examined with a great deal of care into organization of and our expenditure on public works and technical services. These committees have consistently and strongly urged the appalling inefficiency in the Government organization of these matters. They report to you that the annual expenditure on such works and services now amounts to over $250,000,000 per annum, and that they are carried out today in nine different governmental departments. They report that there is a great waste by lack of a national policy of co-ordination, in overlapping with different departments, in competition with each other in the purchase of supplies and materials and the support of many engineering staffs.

They recommend the solution that almost every other civilized government has long since adopted, that is, the co-ordination of these measures into one department under which all such undertakings should be conducted and controlled. As a measure practical to our Government, they have advocated that all such bureaus should be transferred to the Interior Department, and all the bureaus not relating to these matters should be transferred from the Interior to other departments. The committee concludes that no properly organized and directed saving in public works can be made until such a regrouping and consolidation is carried out, and that all of the cheese-paring that normally goes on in the honest effort of Congressional committees to control departmental expenditure is but a tithe of that which could be effected if there were some concentration of administration along the lines long since demonstrated as necessary to the success of private business.

National Budget Advocated

Another question of Government organization to which our engineers have given adhesion is in the matter of the national budget. To minds charged with the primary necessity of advance planning, co-ordination, provision of synchronizing parts in organization, the whole notion of our hit-or-miss system is repugnant. A budget system is not the remedy for all administrative ills; it provides a basis of organization that at least does not paralyze administrative efficiency as our system does today. Through it, the co-ordination of expenditure in Government departments, the prevention of waste and overlapping in Government bureaus, the exposure of the pork barrel, and the balancing of the relative importance of different national activities in the allocation of our national income can all be greatly promoted. Legislation would also be expedited. No budget that does not cover all Government expenditure is worth enactment. Furthermore, without such reorganization as the grouping of construction departments, the proper formulation of a budget would be hopeless. The budget system in some form is so universal in civilized governments and in competently conducted business enterprise, and has been adopted in so many of our States, that its absence in our Federal Government is most extraordinary. It is, however, but a further testimony that it is always a far cry of our citizens from the efficiency in their business to interest in the efficiency of their Government.

Problem of Relationship Between Employer and Employee

Another great national problem to which every engineer in the United States is giving earnest thought, and with which he comes in daily contact, is that of the relationship of employer and employee in industry. In this, as in many other national problems today, we are faced with a realization that the science of economics has altered from a science of wealth to a science of human relationships to wealth. We have gone on for many years throwing the greatest of our ingenuity and ability into the improvement of processes and tools of production. We have until recently greatly neglected the human factor that is so large an element in our very productivity. The development of vast repetition in the process of industry has deadened the sense of craftsmanship, and the great extension of industry has divorced the employer and his employee from that contact that carried responsibility for the human problem. This neglect of the human factor has accumulated much of the discontent and unrest throughout our great industrial population and has reacted in a decrease of production. Yet our very standards of living are dependent on a maximum productivity up to the necessities of our population.

Another economic result is, or will be yet, a repercussion upon the fundamental industry of the United States, that is, agriculture. For the farmer will be unable to maintain his production in the face of a constant increase in the cost of his supplies and labor through shrinkage in productivity in other industries. The penalty of this disparity of effort comes mainly out of the farmer's own earnings.

Collective Bargaining and Sanctity of Contracts the Remedy

I am daily impressed with the fact that there is but one way out, and that is to again re-establish, through organized representation, that personal co-operation between employer and employee in production that was a binding force when our industries were smaller of unit and of less specialization. Through this, the sense of craftsmanship and the interest in production can be re-created and the proper establishment of conditions of labor and its participation in a more skilled administration can be worked out. The attitude of refusal to participate in collective bargaining with representatives of the employees' own choosing is the negation of this bridge to better relationship. On the other hand, a complete sense of obligation to bargains entered upon is fundamental to the process itself.

Employee and Employer Have Common Ground

The interests of employee and employer are not necessarily antagonistic; they have a great common

ground of mutuality, and if we could secure emphasis upon these common interests we would greatly mitigate conflict. Our Government can stimulate these forces, but the new relationship of employer and employee must be a matter of deliberate organization within industry itself. I am convinced that the vast majority of American labor fundamentally wishes to co-operate in production and that basis of good will can be organized and the vitality of production re-created.

Intermittency of Employment Great Loss to the Community

Many of the questions of this industrial relationship involve large engineering problems, as an instance of which I know of no better example than the issue you plan for discussion tomorrow in connection with the soft-coal industry. Broadly, here is an industry functioning badly from an engineering and consequently from an economic and human standpoint. Owing to the intermittency of production, seasonal and local, this industry has been equipped to a peak load of 25 or 30 per cent over the average load. It has been provided with a 25 or 30 per cent larger labor complement than it would require if continuous operation could be brought about. I hope your discussion will throw some light on the possibilities of remedy. There lies in this intermittency not only a long train of human misery through intermittent employment, but the economic loss to the community of over a hundred thousand workers who could be applied to other production, and the cost of coal could be decreased to the consumer. This intermittency lies at the root of the last strike in the attempt of the employees to secure an equal division among themselves of this partial employment at a wage that could meet their view of a living return on full employment.

These are but few of the problems that confront us. But in the formulating of measures of solution, we need a constant adherence to a national ideal and our own social philosophy.

Radicalism and Reaction and Their Influence on the Solution of Economic Problems

In the discussion of these ideals and this social philosophy, we hear much of radicalism and of reaction. They are, in fact, not an academic state of mind but realize into real groups and real forces influencing the solution of economic problems in this community. In their present-day practical aspects, they represent on the one hand roughly various degrees of exponents of socialism, who would directly or indirectly undermine the principle of private property and personal initiative, and, on the other hand, those exponents who in various degrees desire to dominate the community for profit and privilege. They both represent attempts to introduce or preserve class privilege, either a moneyed or a bureaucratic aristocracy. We have, however, in American democracy, an ideal and a social philosophy that sympathize neither with radicalism nor reaction as they are manifested today.

American Democracy Has Stood the Test

For generations the American people have been steadily developing a social philosophy as part of their own democracy—and in these ideals it differs from all other democracies. This philosophy has stood this period of test in the fire of common sense; it is, in substance, that there should be an equality of opportunity—an equal chance—to every citizen. This view that every individual should, within his lifetime, not be handicapped in securing that particular niche in the community to which his abilities and character entitle him, is itself the negation of class. Human beings are not equal in these qualities. But a society that is based upon a constant flux of individuals in the community, upon the basis of ability and character, is a moving, virile mass; it is not a stratification of classes. Its inspiration is individual initiative. Its stimulus is competition. Its safeguard is education. Its greatest mentor is free speech and voluntary organization for public good. Its expression in legislation is the common sense and common will of the majority. It is the essence of this democracy that progress of the mass must arise from progress of the individual. It does not permit the presence in the community of those who would not give full meed of service.

American Conception

Its conception of the State is one that, representative of all the citizens, will in the region of economic activities apply itself mainly to the stimulation of knowledge, the undertaking only of works beyond the initiative of the individual or group, the prevention of economic domination of the few over the many, and the least entrance into commerce that Government functions necessitate.

The method and measures by which we solve this accumulation of great problems will depend upon which of these three conceptions will reach the ascendancy among our people.

Unlawful Radicalism Less Dangerous Than Reaction

If we cling to our national ideals it will mean the final isolation and the political abandonment of the minor groups who hope for domination of the Government, either by "interests" or by radical social theories through the control of our political machinery. I sometimes feel that lawful radicalism in politics is less dangerous than reaction, for radicalism is blatant and displays itself in the open. Unlawful radicalism can be handled by the police. Reaction too often fools the people through subtle channels of obstruction and progressive platitudes. There is little danger of radicalism ever controlling a country with so large a farmer population, except in one contingency. That contingency is from a reflex of continued attempt to control this country by the "interests" and other forms of our domestic reactionaries.

U. S. Must First Solve Its Own Problems if It Is to Contribute to Civilization's Advance

The mighty upheaval following the World War has created turmoil and confusion in our own country no less than in all other lands. If America is to contribute to the advance of civilization, it must first solve its own problems, must first secure and maintain its own strength. The kind of problems that present themselves are more predominantly economic—national as well as international—than at any period in our history. They require quantitative and prospective thinking and a sense of organization.

These are the sort of problems that your profession deals with as its daily toil. You have an obligation to continue the fine service you have initiated and to give it your united skill.

Theoretical Study of Nitrogen Fixation by the Electric Arc—II

Chemical Dynamics of the Nitrogen-Oxygen Reactions at the Temperature of the Arc and During Cooling—Effect of the Rate of Cooling Upon the Dissociation of NO—Cooling Curves*

By CHARLES P. STEINMETZ

If THE gas mixture of N_2, O_2, and NO, of concentration a_0 produced by a temperature T_0, is very slowly cooled, during falling temperature the NO concentration will fall so as to have at every temperature T the corresponding equilibrium concentration a, and as a greatly decreases with decreasing temperature, very little NO will be left in the cold gas mixture. If, however, the gas mixture is cooled very rapidly, from the temperature T_0 to the temperature T_1, at which the reaction velocity has become so slow that NO is practically stable, a greater or lesser part of the high concentration a_0, corresponding to the high temperature T_0, will be saved. The quicker the cooling the more will be saved.

The first problem then is to determine that cooling curve, that is, that rate of cooling at which with decreasing temperature the NO concentration still reaches the temperature equilibrium at each temperature; a materially more rapid cooling would be required to save a great part of the NO produced at high temperature.

Mathematically, however, the problem cannot be put in this form, as the reaction curves are exponentials, and the equilibrium concentration at each temperature is reached theoretically only after infinite time.

The problem thus must be put in the form to determine the cooling curve, that is, the rate of temperature decrease, by which the NO concentration a at each temperature exceeds the equilibrium concentration by a small constant value x. That is, to determine the cooling rate $\frac{dT}{dt}$, by which the NO concentration at each temperature T is $a + x$, where a is the equilibrium concentration corresponding to the temperature T, and x a small constant quantity.

Concentration of NO in Air

The equilibrium concentration of NO is given by equation (13):

$$C = \frac{a^2}{\left(n - \frac{a}{2}\right)\left(o - \frac{a}{2}\right)} \tag{43}$$

where: a = concentration of NO,
n = total or initial N_2 concentration, = 0.777 in air,
o = total or initial O_2 concentration, = 0.210 in air,

and C is the equilibrium constant, which is given as function of the temperature T by van't Hoff's equation:

$$\frac{d \log_e C}{dT} = -\frac{Q}{RT} \tag{15}$$

Substituting (43) into (15) gives:

$$\frac{d}{dT}\left| \log_e a^2 - \log_e\left(n - \frac{a}{2}\right) - \log_e\left(o - \frac{a}{2}\right)\right| = -\frac{Q}{RT}$$

and expanded:

$$\frac{da}{dT}\left(\frac{2}{a} + \frac{1}{2n - a} + \frac{1}{2o - a}\right) = -\frac{Q}{RT}$$

thus:

$$\frac{da}{dT} = \frac{-Q}{RT^2\left(\frac{2}{a} + \frac{1}{2n - a} + \frac{1}{2o - a}\right)} = \frac{21{,}600}{T^2\left(\frac{2}{a} + \frac{1}{1.554 - a} + \frac{1}{0.42 - a}\right)} \tag{44}$$

Values of the rate of change of the NO concentration a, with the temperature T: $\frac{da}{dT}$ are given in Table IV, from 800 to 4200 deg. abs., and plotted in Fig. 2, together with the values of a.

Lag in Dissociation

If at constant temperature T, the NO concentration exceeds the equilibrium value a by a small amount x,

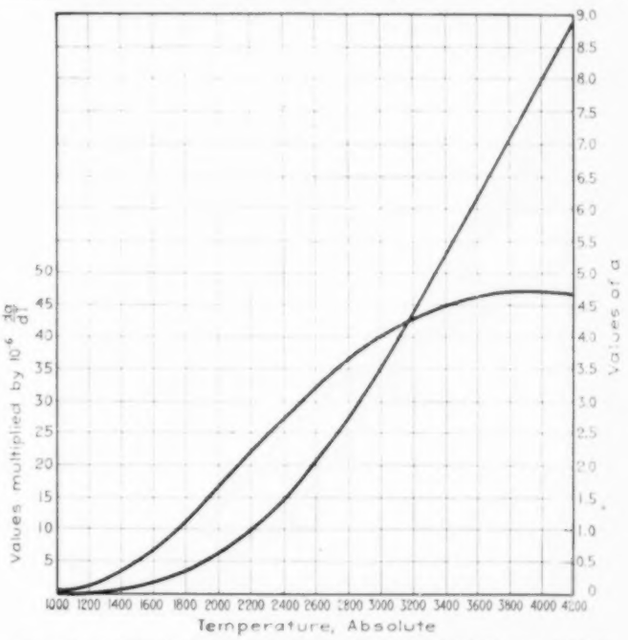

FIG. 2. THERMAL EQUILIBRIUM—NO CONCENTRATION IN AIR

that is, $a + x$, the rate of dissociation is given by equation (26) as:

$$v = \frac{dx}{dt} = c_2(a + x)^2 - c_1\left(n - \frac{a}{2} - \frac{x}{2}\right)\left(o - \frac{a}{2} - \frac{x}{2}\right) \tag{45}$$

*For Part I see CHEM. & MET. ENG., vol. 22, No. 7, Feb. 18, 1920, pp. 299-304.

where c_1 and c_2 are the velocity constants given in Table I, as functions of the temperature T.

Expanding (45) and substituting the equilibrium conditions:

$$c_2 a^2 - c_1\left(n - \frac{a}{2}\right)\left(o - \frac{a}{2}\right) = 0$$

gives:

$$v = \frac{dx}{dt} = x\left[2a\left(c_2 - \frac{c_1}{4}\right) + \frac{c_1}{2}(n + o)\right] \qquad (46)$$

or, as c_1 is small compared with c_2:

$$v = \frac{dx}{dt} = x[2ac_2 + \frac{c_1}{2}(n + o)]$$

$$= x(2ac_2 + 0.493c_1) \qquad (47)$$

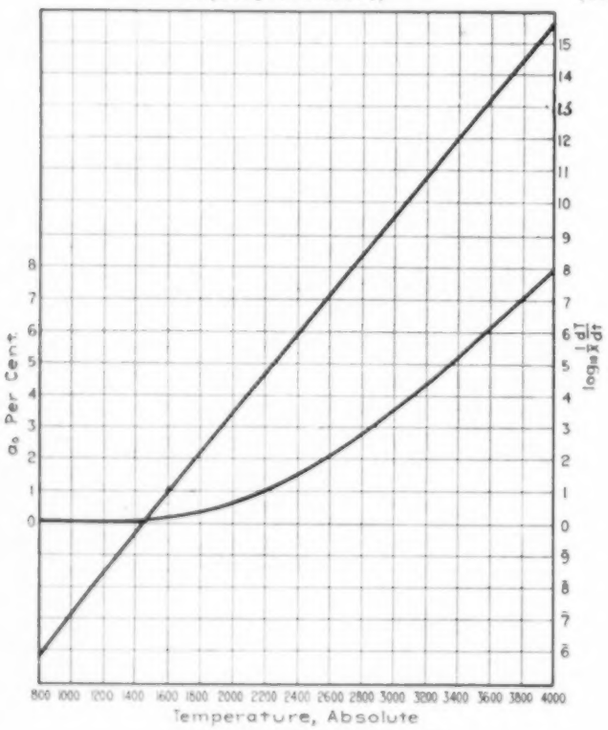

FIG. 3. COOLING CURVES

As the second term in equation (47) is small compared with the first term, this equation can be approximated by:

$$v = \frac{dx}{dt} = 2xac_2 \qquad (48)$$

Values of

$$\frac{1}{x}\frac{dx}{dt} = 2ac_2 - 0.493c_1 \qquad (49)$$

for air, are given in Table IV, and values of:

$$\log_{10} -\frac{1}{x}\frac{dx}{dt}$$

are plotted in Fig. 3 with T as abscissæ, in Fig. 4 with $\log_{10} T$ as abscissæ.

From (44) follows, by integration:

$$x = x_o e^{-(2ac_2 - 0.493c_1)t} \qquad (50)$$

Cooling Curves

If the temperature T of the gas mixture falls with the time t at such a rate

$$\frac{dT}{dt} = f_o(T) \qquad (51)$$

that the change in concentration by dissociation, $\frac{dx}{dt}$, by equation (51), equals the change of equilibrium concentration with the temperature, $\frac{da}{dT}$, then at the decrease of temperature with the time, the decreasing concentration of NO remains by a constant value x above the equilibrium concentration a corresponding to the respective time. That is, on such cooling curve, the NO concentration lags by the constant value x above the falling equilibrium concentration.

The condition herefor obviously is:

$$\frac{dx}{dt} = \frac{da}{dT} \times \frac{dT}{dt} \qquad (52)$$

Thus:

$$\frac{dT}{dt} = f_o(T) = \frac{dx}{dt} \div \frac{da}{dT} \qquad (53)$$

is the equation of the cooling curve giving a constant excess x above the temperature equilibrium values a.

Substituting (46) and (44) into (53), and expanding, gives:

$$\frac{dT}{dt} = -\frac{xRT^2}{Q}[2a\left(c_2 + \frac{c_1}{4}\right) + \frac{c_1}{2}(n + o)]\left(\frac{2}{a} + \frac{1}{2n - a} + \frac{1}{2o - a}\right) = \frac{xT^2}{21{,}600}(2ac_2 + 0.493\,c_1)\left(\frac{2}{a} + \frac{1}{1.554 - a} + \frac{1}{0.42 - a}\right) \qquad (54)$$

Values of $\frac{1}{x}\frac{dT}{dt}$, that is, the cooling curves giving constant excess concentration x, are calculated in Table IV.

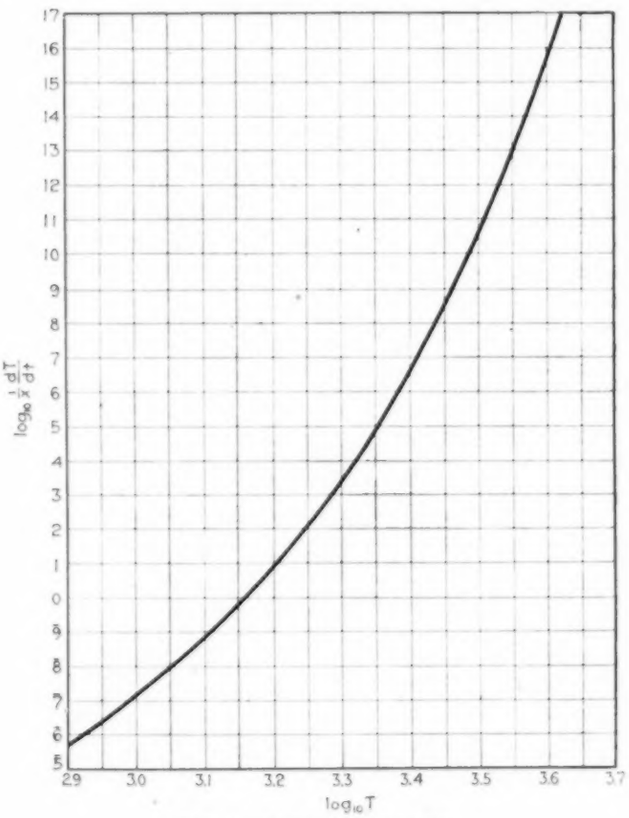

FIG. 4. COOLING CURVES

Inversely now, if a cooling function is given, as for instance, cooling by the radiation law

$$\frac{dT}{dt} = f(T) = bT^4 \qquad (55)$$

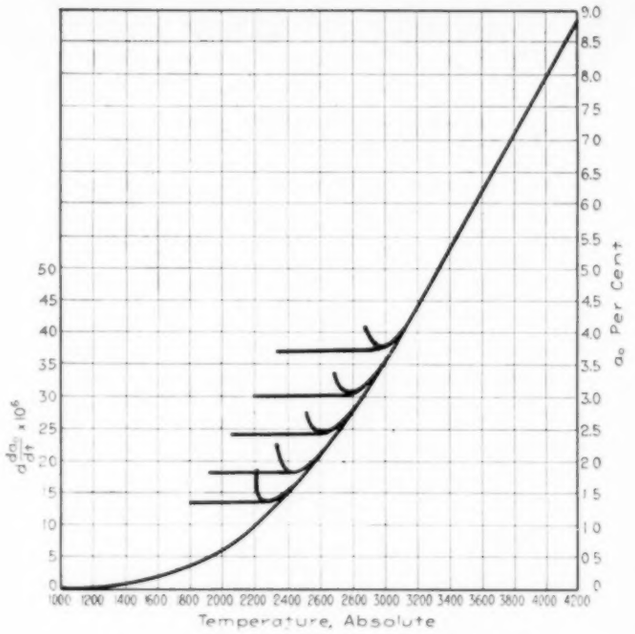

FIG. 5. COOLING BY RADIATION LAW

or cooling by heat conduction, at a rate proportional to the temperature:

$$\frac{dT}{dt} = f(T) = bT \qquad (56)$$

or cooling at a constant rate, as for instance, by an air blast mixing cold air with the gases:

$$\frac{dT}{dt} = f(T) = b \qquad (57)$$

then, by substituting the values of the cooling rate, (55) to (57), etc., into equation (54), the value x is found, that is, for each temperature T, the value x of the NO concentration, by which it exceeds the equilibrium concentration a of this temperature. Provided, however, that x is small compared with a.

This can conveniently be done by plotting the equation (54) in the form:

$$\frac{1}{x}\frac{dT}{dt} = \frac{T^2}{21{,}600}(2ac_2 - 0.493c_1)\left(\frac{2}{a} + \frac{1}{1.554 - a} + \frac{1}{0.42 - a}\right) \qquad (58)$$

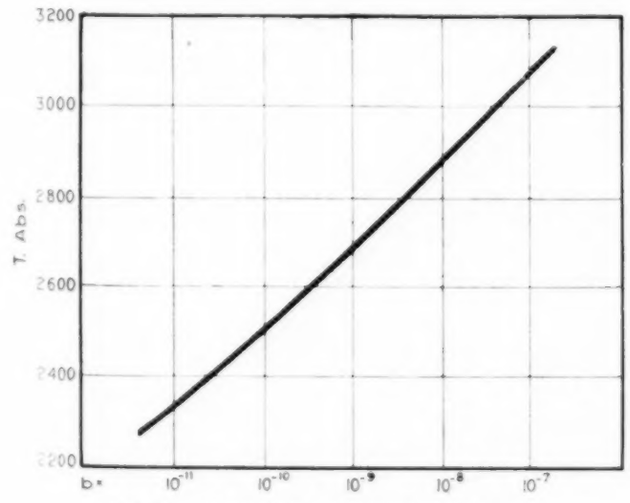

FIG. 6a. COOLING BY RADIATION L. W

TABLE IV. COOLING CURVES

T Degs. Abs.	$\frac{da}{dT}$ Air $\times 10^{-6}$	$\frac{1}{x}\frac{dx}{dt}$ Air	$\frac{1}{x}\frac{dT}{dt}$ Air	$\text{Log}_{10}\frac{1}{x}\frac{dT}{dt}$ Air	$\text{Log}_{10} T$
800	0.034	2.0×10^{-12}	5.9×10^{-6}	$\bar{5}.771$	2.903
900	0.106	3.0×10^{-11}	2.8×10^{-4}	$\bar{6}.447$	2.954
1000	0.323	4.2×10^{-10}	1.3×10^{-3}	$\bar{7}.114$	3.0
1100	0.63	3.62×10^{-9}	5.75×10^{-3}	$\bar{7}.760$	3.041
1200	1.28	3.32×10^{-8}	2.6×10^{-2}	$\bar{8}.415$	3.079
1300	2.1	2.42×10^{-7}	1.16×10^{-1}	$\bar{9}.064$	3.11
1400	3.3	1.64×10^{-6}	5.0×10^{-1}	$\bar{9}.699$	3.046
1500	4.8	1.02×10^{-5}	2.12	0.326	3.176
1600	6.7	6.13×10^{-5}	9.2	0.964	3.204
1700	8.7	3.31×10^{-4}	3.8×10	1.580	3.230
1800	11.2	1.78×10^{-3}	1.59×10^{2}	2.201	3.255
1900	13.8	9.3×10^{-3}	6.73×10^{2}	2.828	3.279
2000	16.4	4.62×10^{-2}	2.82×10^{3}	3.450	3.301
2100	19.0	2.23×10^{-1}	1.18×10^{4}	4.072	3.322
2200	21.7	1.05	4.85×10^{4}	4.686	3.342
2300	24.3	4.86	2.00×10^{5}	5.301	3.362
2400	26.9	2.22×10	8.25×10^{5}	5.916	3.380
2500	29.4	9.9×10	3.37×10^{6}	6.528	3.398
2600	31.9	4.36×10^{2}	1.36×10^{7}	7.133	3.415
2700	34.4	1.94×10^{3}	5.63×10^{7}	7.750	3.431
2800	36.7	8.41×10^{3}	2.29×10^{8}	8.360	3.447
2900	38.5	3.57×10^{4}	9.3×10^{8}	8.968	3.462
3000	40.1	1.52×10^{5}	3.8×10^{9}	9.580	3.477
3100	41.5	6.34×10^{5}	1.53×10^{10}	10.185	3.491
3200	42.8	2.64×10^{6}	6.17×10^{10}	10.790	3.505
3300	44.0	1.10×10^{7}	2.5×10^{11}	11.398	3.518
3400	45.0	4.53×10^{7}	1.01×10^{12}	12.004	3.531
3500	45.7	1.86×10^{8}	4.08×10^{12}	12.611	3.544
3600	46.2	7.60×10^{8}	1.65×10^{13}	13.217	3.556
3700	46.6	3.06×10^{9}	6.56×10^{13}	13.817	3.568
3800	46.9	1.25×10^{10}	2.67×10^{14}	14.426	3.580
3900	47.0	4.98×10^{10}	1.06×10^{15}	15.025	3.591
4000	47.0	2.00×10^{11}	4.26×10^{15}	15.629	3.602
4100	46.9	8.00×10^{11}	1.71×10^{16}	16.233	3.613
4200	46.8	3.12×10^{12}	6.66×10^{16}	16.823	3.623
∞	∞	∞	∞	∞	∞

with T as abscissæ, this curve being independent of x, and then plotting, of the actual cooling curve $f(T)$, the values $\frac{1}{x} f(T)$ for various values of x. The points of

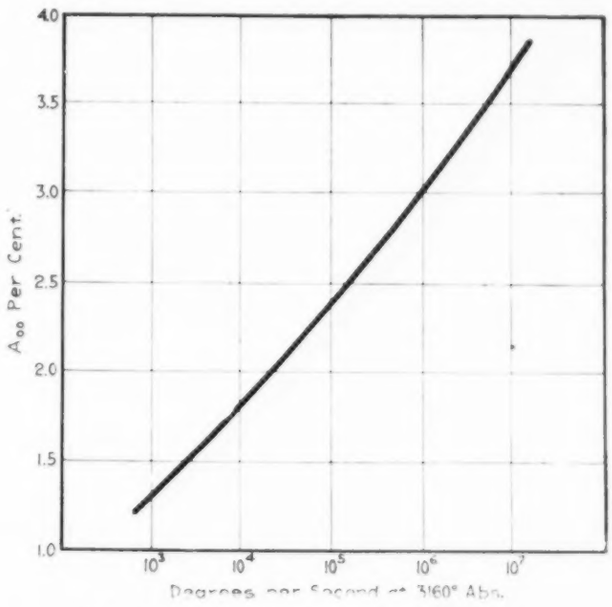

FIG. 6b. COOLING BY RADIATION LAW

intersection with (58) give the temperatures T, at which the excess concentration x exists, and herefrom then a new concentration curve can be plotted, with $a + x$ as ordinates, giving the change of concentration with the temperature, when the temperature decreases by the chosen cooling law $\frac{dT}{dt} = f(T)$.

Cooling by Radiation

The radiation law

$$\frac{dT}{dt} = bT^4 \qquad (59)$$

gives: $$\log_{10} -\frac{dT}{dt} = 4 \log_{10} T + \log_{10} b \qquad (60)$$

At: $T = 3160$ deg. abs., $b = 10^{-7}\ 10^{-8}\ 10^{-9}\ 10^{-10}\ 10^{-11}$ gives a cooling rate, per millisecond of:

10,000 1000 100 10 1 deg. C.

If then x is constant, it follows, from (42):

$$\log_{10} -\frac{1}{x}\frac{dT}{dt} = 4 \log_{10} T + \log_{10} b - \log_{10} x \qquad (61)$$

a linear equation in $\log_{10} \frac{1}{x}\frac{dT}{dt}$ and $\log_{10} T$.

Plotting then from Table IV, $\log_{10} \frac{1}{x}\frac{dT}{dx}$ as function of $\log_{10} T$, in Fig. 4, as the dissociation function of NO, and taking the points of intersection of this curve with the straight lines (61) corresponding to various values of x, gives $\log_{10} T_0$ and T_0, the critical temperatures, at which in cooling by the law (59) the concentration exceeds the equilibrium value a_0 of temperature T_0, by the value x.

Herefrom then follows the concentration $a_0 + x$ of the cooling curve (59).

Table V gives, for various values of b and of x, the values of T_0, a_0 and $a_0 + x$.

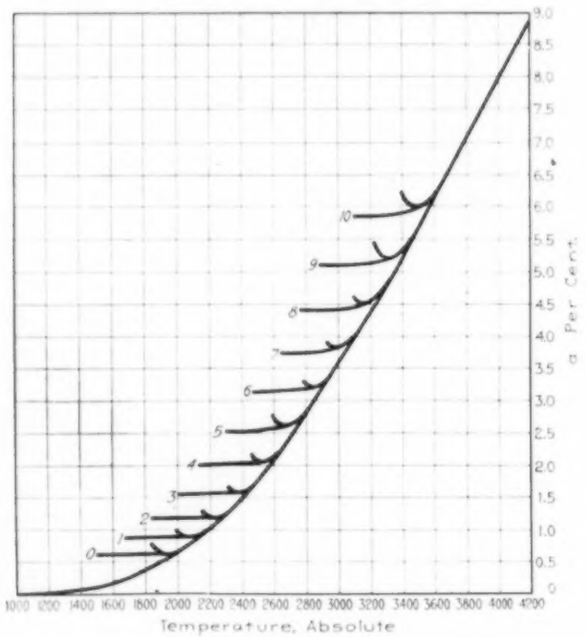

FIG. 7. CONSTANT RATE OF COOLING

a_0 is taken from the plot of a_0 against T, in Fig. 5, and $a_0 + x$ plotted on the same curve sheet, giving an estimate of the final values of concentrations of NO in air.

These are plotted, with b as abscissæ, in Fig. 6, and recorded in Table VI, together with the temperature T_0', at which the minimum of the $a_0 + x$ curve is reached, and the temperature T_{00}, at which the final value of NO concentration, a_{00}, would be the equilibrium values, and the temperature T, at which $x = 0.1$.

Cooling at Constant Rate

Cooling by mixing the arc gases with cold air, as is usually done in arc furnaces, may probably be best approximated by cooling at constant rate, at least within the initial range.

A temperature gradient at the arc surface of 1000 deg. C. per cm. appears reasonable, and even several times as high gradients may be expected in quickly moving arcs. Assuming an air velocity of 100 m. per sec., which is moderate, would give a cooling rate of 10^7 deg. per sec.

Thus, in cooling at uniform rate, by the cooling law

$$\frac{dT}{dt} = -b \qquad (62)$$

TABLE V. COOLING CURVES $\frac{dT}{dt} = bT^4$

	$x =$	0.05	0.1	0.2	0.4	0.7	1.0	% Final
$b = 10^{-7}$								
10^7 degrees	$T_0 =$	3125	3070	3015	2960	2910	2885	
per second	$a_0 =$	4.04	3.82	3.60	3.38	3.20	3.10	
at 3160 deg. abs.	$a_0 + x =$	4.09	3.92	3.80	3.78	3.90	4.10	3.70
$b = 10^{-8}$								
10^6 degrees	$T_0 =$	2940	2880	2820	2765	2715	2685	
per second	$a_0 =$	3.30	3.09	2.86	2.68	2.50	2.39	
	$a_0 + x =$	3.35	3.19	3.06	3.08	3.20	3.39	3.00
$b = 10^{-9}$								
10^5 degrees	$T_0 =$	2755	2700	2640	2585	2540	2510	
per second	$a_0 =$	2.64	2.44	2.24	2.03	1.89	1.80	
	$a_0 + x =$	2.69	2.54	2.44	2.43	2.59	2.80	2.39
$b = 10^{-10}$								
10^4 degrees	$T_0 =$	2506	2505	2450	2400	2355	2325	
per second	$a_0 =$	1.96	1.79	1.62	1.48	1.36	1.29	
	$a_0 + x =$	2.01	1.89	1.82	1.88	2.06	2.29	1.79
$b = 10^{-11}$								
10^3 degrees	$T_0 =$	2375	2325	2270	2220	2175	2150	
per second	$a_0 =$	1.42	1.29	1.15	1.03	0.94	0.08	
	$a_0 + x =$	1.47	1.39	1.35	1.43	1.64	1.88	1.33

TABLE VI. RADIATION COOLING

Cooling constant..... $b =$ Or	10^{-7} 10^7	10^{-8} 10^8	10^{-9} 10^9	10^{-10} 10^4	10^{-11} 10^3 deg. per sec. at 3160 deg. abs.
Final NO concentration.... $a_{00} =$	3.70	3.00	2.39	1.79	1.33%
Corresp. equilibrium temp.. $T_{00} =$	3035	2885	2685	2505	2340 deg. abs.
Temp. of $a_0 + x$ minimum... $T' =$	2980	2800	2610	2430	2270 deg. abs.
Temp. of $x = 0.1$..... $T =$	3070	2880	2700	2505	approx. 2325

TABLE VII. COOLING CURVES $\frac{dT}{dt} = b$

	$x =$	0.05	0.1	0.2	0.4	0.6	0.8	1.0	Per Cent Final
$b = 10^{10}$	$T_0 =$	3615	3565	3515	3470	3435	3415	3400	
Degrees per	$a_0 =$	6.25	6.00	5.79	5.58	5.42	5.33	5.22	
second	$a_0 + x =$	6.30	6.10	5.99	5.98	6.02	6.13	6.25	5.86
$b = 10^9$	$T_0 =$	3450	3400	3345	3300	3270	3250	3235	
Degrees per	$a_0 =$	5.50	5.25	5.02	4.80	4.64	4.55	4.47	
second	$a_0 + x =$	5.55	5.35	5.22	5.20	5.24	5.35	5.47	5.10
$b = 10^8$	$T_0 =$	3285	3230	3185	3135	3105	3085	3070	
10^8 degrees	$a_0 =$	4.74	4.47	4.30	4.10	3.97	3.89	3.84	
per second	$a_0 + x =$	4.79	4.57	4.50	4.50	4.57	4.69	4.84	4.42
$b = 10^7$	$T_0 =$	3120	3070	3025	2970	2935	2915	2900	
10^7 degrees	$a_0 =$	4.04	3.84	3.65	3.42	3.29	3.21	3.15	
per second	$a_0 + x =$	4.09	3.94	3.85	3.82	3.89	4.01	4.15	3.76
$b = 10^6$	$T_0 =$	2950	2895	2850	2805	2775	2755	2735	
10^6 degrees	$a_0 =$	3.36	3.13	3.00	2.82	2.71	2.63	2.55	
per second	$a_0 + x =$	3.41	3.23	3.20	3.22	3.31	3.43	3.55	3.14
$b = 10^5$	$T_0 =$	2790	2735	2685	2635	2610	2590	2570	
10^5 degrees	$a_0 =$	2.77	2.55	2.37	2.20	2.10	2.03	1.98	
per second	$a_0 + x =$	2.82	2.65	2.57	2.60	2.70	2.83	2.98	2.52
$b = 10^4$	$T_0 =$	2625	2570	2525	2475	2450	2430	2410	
10^4 degrees	$a_0 =$	2.16	1.98	1.84	1.67	1.60	1.55	1.50	
per second	$a_0 + x =$	2.21	2.08	2.04	2.07	2.20	2.35	2.50	2.00
$b = 10^3$	$T_0 =$	2455	2410	2360	2310	2285	2265	2250	
1000 degrees	$a_0 =$	1.60	1.50	1.37	1.25	1.18	1.13	1.10	
per second	$a_0 + x =$	1.65	1.60	1.57	1.65	1.78	1.93	2.10	1.54
$b = 10^2$	$T_0 =$	2300	2250	2200	2150	2125	2105	2085	
100 degrees	$a_0 =$	1.21	1.10	0.98	0.89	0.83	0.79	0.76	
per second	$a_0 + x =$	1.25	1.20	1.18	1.29	1.43	1.59	1.76	1.14
$b = 10$	$T_0 =$	2135	2085	2040	1990	1960	1940	1925	
10 degrees	$a_0 =$	0.85	0.76	0.68	0.60	0.55	0.52	0.50	
per second	$a_0 + x =$	0.90	0.86	0.88	1.00	1.15	1.32	1.50	0.85
$b = 1$	$T_0 =$	1970	1925	1875	1830	1805	1785	1765	
1 degree	$a_0 =$	0.58	0.50	0.43	0.38	0.34	0.32	0.30	
per second	$a_0 + x =$	0.63	0.60	0.63	0.78	0.94	1.12	1.30	0.60

TABLE VIII. CONSTANT RATE COOLING

b = cooling constant, degrees per second.
a_{00} = final NO concentration, per cent
T_{00} = corresponding equilibrium temperature
T' = temperature of $a_0 + x$ minimum
T = temperature where $x = 0.1$ per cent

$b =$	10^{10}	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10	1
$a_{00} =$	5.86	5.10	4.42	3.76	3.14	2.52	2.00	1.54	1.14	0.85	0.60
$T_{00} =$	3530	3360	3210	3045	2890	2725	2580	2415	2270	2130	2010
$T' =$	3470	3300	3170	3000	2850	2670	2530	2380	2210	2070	1950
$T =$	3565	3400	3215	3070	2895	2735	2570	2410	2250	2085	1925

the range of b from 10^{10} to 1 would give the entire range from the lowest cooling rate, up to and beyond the highest feasible rate.

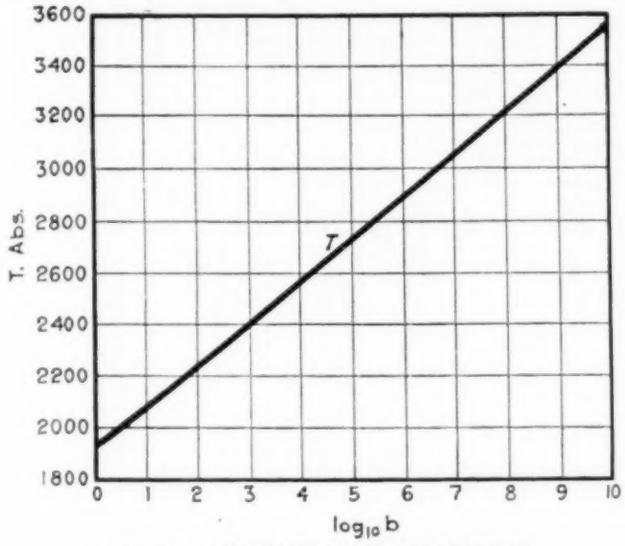

FIG. 8a. CONSTANT RATE OF COOLING

From (62) follows:

$$\log_{10} -\frac{1}{x}\frac{dT}{dt} = \log_{10} b - \log_{10} x \qquad (63)$$

For each value of the cooling constant b, and for the various values of x, the values of $\log_{10} -\frac{1}{x}\frac{dT}{dt}$ thus are found by equation (63), and for these values from Fig. 3 the corresponding values of time T_0 are taken and recorded in Table VII, together with the values of a_0, corresponding to T_0, and the values of $a_0 + x$. These are plotted in Fig. 7.

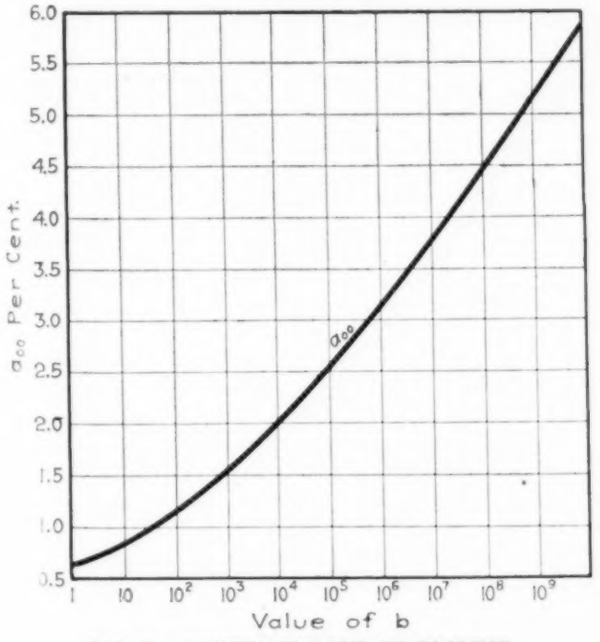

FIG. 8b. CONSTANT RATE OF COOLING

Here again, as in Fig. 5, the curves of $a_0 + x$ become an approximation only at the minimum values, and inaccurate at temperatures below the minimum values, due to the assumption that x is small compared to a_0 ceasing to apply. The actual curve and the final limiting value a_{oo} of $a_0 + x$ thus are estimated and recorded in the last column of Table VII. These are plotted, with b as abscissa, in Fig. 8, and Table VIII gives, for various values of b, the final concentration a_{oo}, the temperature T_{oo}, at which a_{oo} would be the equilibrium concentration, and the temperature T' of the minimum value of the $a_0 + x$ curve.

It is interesting to note from Tables V to VIII, and the corresponding Figs. 5 to 8, the similarity of the curves, though the two cooling laws considered: cooling at constant rate and cooling at a rate proportional to the fourth power of the temperature, are nearly the two extremes.

Roughly, a tenfold increase of the cooling rate increases the final NO concentration a_{oo} by about $\frac{1}{2}$ per cent (somewhat more at the higher, less at the lower cooling rates).

With decreasing temperature, on these two cooling laws and thus also any intermediary cooling law, the NO concentration $a_0 + x$ follows the equilibrium concentration a_0 without appreciable deviation, down to a certain critical temperature. Then the calculated NO concentration $a_0 + x$ rapidly rises above the equilibrium concentration, reaches a minimum and then increases again, all within a narrow range of temperature. As stated before, the minimum and the rise at temperatures below that of the minimum are only apparent, due to the approximate equation of $a_0 + x$ ceasing to apply, and the actual curve of NO concentration $a_0 + x$ reaches a constant value, very little lower than the minimum value of the plotted curve, so that the latter is a fair approximation of the final concentrations.

It is interesting to note that the entire range, from the temperature where the NO concentration still practically follows the equilibrium curve, down to the temperature where the NO concentration has practically become constant, is within a temperature interval of about 100 degrees.

The final NO concentration a_{oo} corresponds to equilibrium concentration a_0, which is very close to the final concentration a_{oo}.

Thus, substituting in equation (58) the cooling function

$$\frac{dT}{dt} = f(T)$$

and substituting $x = 0.001$, gives, for air:

$$f(T) = \frac{T^2 10^{-6}}{21.6}(2ac_2 - 0.493c_1)\left(\frac{2}{a} + \frac{1}{1.554 - a} + \frac{1}{0.42 - a}\right) \qquad (64)$$

This gives the final concentration $a_{oo} = a$, which is derived by the cooling law $f(T)$, provided, however, that the arc temperature is higher than the temperature T corresponding to a.

(Part III will be published in our next issue.)

Government Kelp Plant to Continue Operations

The Government's kelp plant at Summerland, Cal., can be maintained from the returns from its potash output alone. In addition, nearly as much return is made from the four principal byproducts, which are iodine, salt, ammonia and bleaching carbon. The bleaching carbon is being prepared and sold at the Summerland plant at 15c. a lb. In recovering the ammonia enough combustible gas is released to take care of the fuel requirements of the plant.

Testing Natural Gas for Carbon Black

By Roy O. Neal*

BEFORE work is begun on a plant for the production of carbon black from natural gas, the gas should be tested. The actual amounts of carbon black obtained by the same process when using different gas may vary decidedly, as is shown in Table I. The quantity recovered closely follows the percentage of ethane[1], heating value and amount of elementary carbon calculated from the hydrocarbons determined by analysis. The gas from Louisiana has the lowest percentage of nitrogen and the highest percentage of hydrocarbons, namely, 97.56, yet when burned at a factory it gives the smallest yield of carbon black. This is due to the large proportion of methane, which contains 33.5 lb. of carbon per thousand cu.ft., whereas ethane contains 67 lb. of carbon. The two gases from West Virginia have very similar compositions and give approximately the same yield of carbon black. The gas supplied to the plant in Wyoming has the largest calorific value, carbon content and considerably more ethane than any of the other gases and produces the greatest yield. With the richer gases not only the actual quantity of carbon obtained is larger, but also the per cent recovery increases. An examination of the chemical analysis of a gas is probably as trustworthy an indication of the available carbon black as that obtained with a small portable apparatus where gas is burned and the deposited carbon black is collected and weighed.

TABLE I. CARBON CONTENT AND QUANTITY OF CARBON BLACK RECOVERED BY CHANNEL PROCESS

	Louisiana (a) Per Cent	West Virginia (b) Per Cent	West Virginia (c) Per Cent	Wyoming (d) Per Cent
Methane [2]	94.12	70.75	65.23	45.45
Ethane	3.44	24.14	30.07	43.10
Carbon Dioxide	0.50	0.28	1.56	0.96
Nitrogen	1.94	4.83	3.14	9.49
Heating value [3]	962	1,086	1,134	1,176
Lb. carbon per 1,000 cu.ft. of gas [4]	33.8	39.9	42.3	44.3
Reported as carbon black, lb. per 1,000 cu. ft.	0.80	1.00	1.10	1.40
Per cent recovery	2.4	2.5	2.6	3.1

[1] Chemical analyses of gases were made by Donald B. Dow, junior chemist of Bartlesville Station, U. S. Bureau of Mines.
[2] Net heating value in B.t.u. per cu.ft. at 32 deg. F. and 760 mm. pressure.
[3] Calculated from carbon content of methane and ethane.

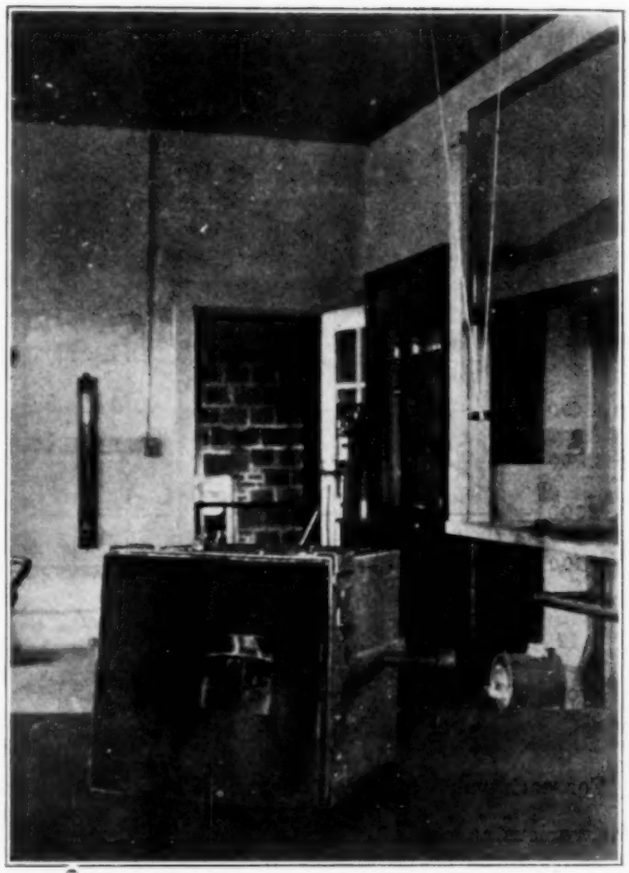

FIG. 2. APPARATUS DETACHED FOR TRANSPORTATION

The writer has designed an apparatus for determining the quantity of carbon black which one might expect to obtain from an unknown gas. Details of the apparatus are shown in Fig. 1. The apparatus is made of 16-gage sheet iron held together with ⅛-in. rivets. The carbon black is deposited upon a plate 8 x 10¾ x ¼ in. and is removed by a scraper 1 x 8 x 1/16 in. that is operated by hand. The draft is controlled by eight 1-in. ventilating holes provided with covers, which are pivoted above the holes, and by a revolving damper located at the top of the hood. The pipe carrying the lava tips can be lowered below the depositing plate and held at any distance by attaching a plug in stopper holes below the supports. The hopper carries a sliding door for removing the carbon black. Lava tips capable of burning about 4 cu.ft. of gas per hr. are used. The hood, hopper and legs are detachable and fit into the central portion of the device to facilitate transporting in the field. The apparatus

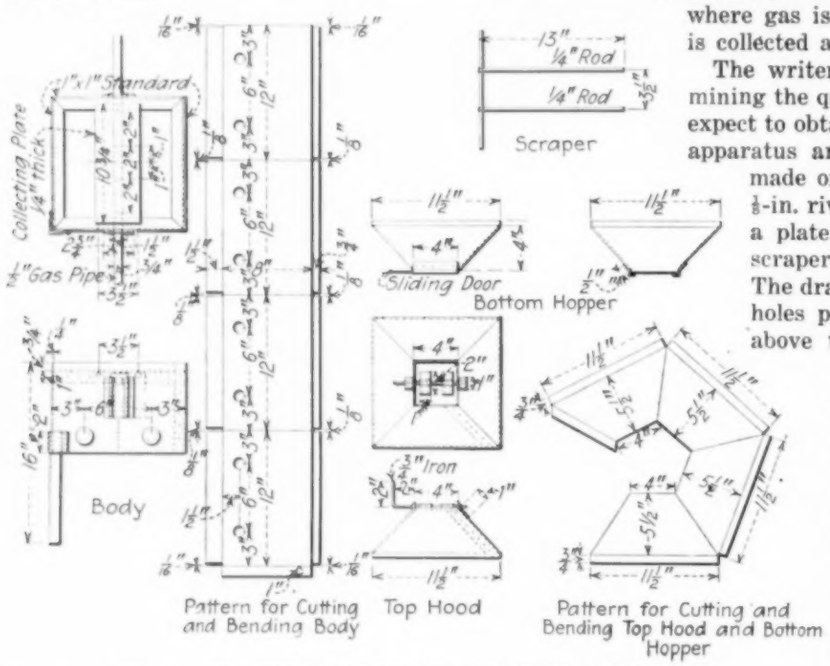

FIG. 1. DETAILS OF PORTABLE TESTING APPARATUS

*Formerly chemical engineer, Petroleum Division, Bureau of Mines.

[1]For the chemical analysis of natural gas the reader is referred to "The Sampling and Examination of Mine Gases and Natural Gas," George A. Burrell and F. M. Seibert; Bulletin 42, Bureau of Mines, 1913. "Gas Analysis," L. M. Dennis, The MacMillan Co., New York, 1913.

ready for transporting in the field is shown in Fig. 2. The apparatus can be used in the field by connecting directly to the supply of gas and using suitable wind breaks if assembled in the field, or can be used in the laboratory by obtaining a sample of gas under pressure in a steel cylinder.

The source of supply of gas is connected with a meter registering at least as small a quantity as one-tenth of a cu.ft. and on this line should be a quarter-inch needle valve in order to limit the flow of gas through the apparatus. Between the meter and the apparatus, where the gas is burned, is attached a "U" tube for determining the pressure of the gas. The top of the lava tips should be about 2½ in. below the depositing plate and a gas pressure of from ½ to 1 in. of water should be maintained. These factors will of necessity be changed when examining different gases and in the preliminary tests changes should be made until the

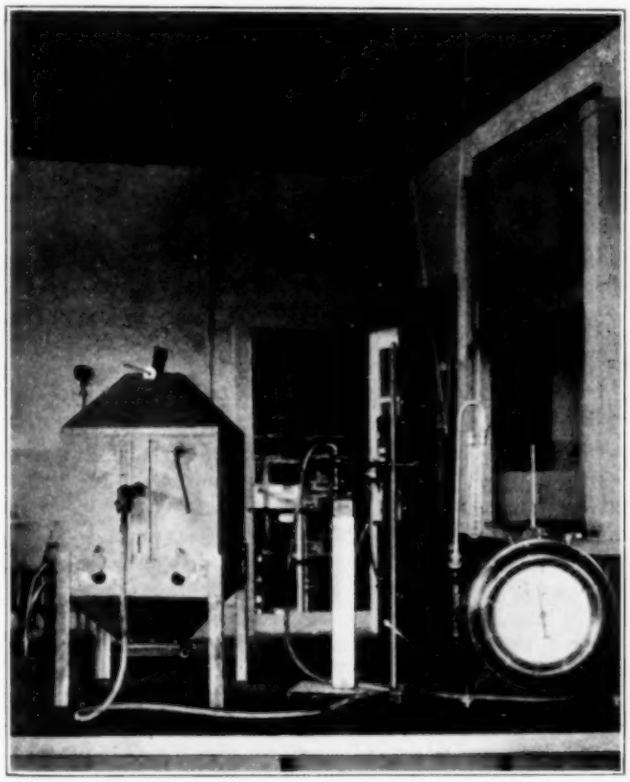

FIG. 2. APPARATUS FOR DETERMINING THE QUANTITY OF CARBON BLACK IN GASES

largest recovery is obtained. A test should last at least an hour, during which time 15 or 20 cu.ft. of gas should be burned. It is possible to make a test without using the meter in the field by previously calibrating the apparatus against a meter in which different pressures on the manometer tube are observed and the time recorded. This will give fairly accurate data on volumes, provided, of course, that the lava tips are not broken, plugged, or partly restricted by foreign matter after the apparatus has been standardized. During the test the carbon black should be removed from the collecting plate by the scraper every 10 min., and at the end of test the carbon which is deposited on the sides of apparatus and plate is removed by use of a small brush. This accumulated carbon black is then weighed. From the data on the volume of gas burned, quantity of carbon black collected and pressure on the gas, the quantity of carbon black which one might expect to obtain in plant operation from a given gas can be calculated. The apparatus assembled is shown in Fig. 3.

In both methods only comparative results are obtained. The portable apparatus will give results approximately paralleling those procured in commercial plants using the channel system, but if some other process is used, it is necessary to standardize the apparatus against a plant where conditions will be similar to those where gas in question is examined.

White Oil Corp.,
Tulsa, Okla.

Relation Between Viscosity and Penetrance of Creosote Into Wood

BY ERNEST BATEMAN

IT HAS been generally presumed in the wood preservation industry that the viscosity of a creosote oil is an important factor of the amount of penetration which can be obtained in creosoted woods. The nature of the influence of viscosity, however, has not been worked out. In fact, Bond makes a statement (A. W. P. A., 1913), "that there was no apparent relation between the viscosity of mixtures of creosote with three carbon-free tars and three normal tars and the corresponding absorptions and penetrations into the longleaf pine." Later Teesdale and MacLean in a more comprehensive work (U. S. Department of Agriculture Bulletin 607) state that "the relative viscosities of mixtures of coal-tar creosote and coal tar from different sources are not necessarily a true index of their ability to penetrate wood. In these tests the viscosities of mixtures containing different tars did not appear to have any definite relation to the ease or difficulty of penetration." These statements were based on viscosities as measured by the Engler viscosimeter, which gives a purely empirical measure of the viscosity. Since the publication of Bond's work, Weidner of the United States Bureau of Standards has published (A. S. T. M., 1915) tables for converting Engler numbers to absolute viscosities. The data collected by Bond and by Teesdale and MacLean and also some additional unpublished data have been recalculated to absolute viscosities, with the result that very definite relationships are found to exist between the viscosity and the penetration of creosote in the longleaf pine and noble fir, and it seems likely that the same or nearly the same sort of relation would hold for other species.

CALCULATED RESULTS

In general the equation $xy = k$, where x is longitudinal penetration, y the absolute viscosity at the temperature of treatment, and k a constant for the wood, appears to answer all the data available on the longitudinal penetration of longleaf pine and noble fir when the treatments were made with 75-lb. pressure for 2 hr. The results of a large number of penetration experiments with different oils in both longleaf pine sapwood and noble fir are given in Fig. 1. The maximum equation of the curve is $xy = 0.6$; the equation of the minimum values is $xy = 0.09$; while the equation of the average values is $xy = 0.3$. The effect of the addition of carbon-free tar and tar containing various amounts of free carbon to the same coal-tar creosote is shown in Fig. 2. The effect is merely that which might be expected from increasing the absolute viscosity of the oil; similarly it can be shown that the effect of raising the temperature of the oil at the time of treatment is

that which would be expected from the change of viscosity which results, provided the other variables are constant. The data available on radial and tangential penetration are not so complete as those for longitudinal penetration; nevertheless such as are available seem to

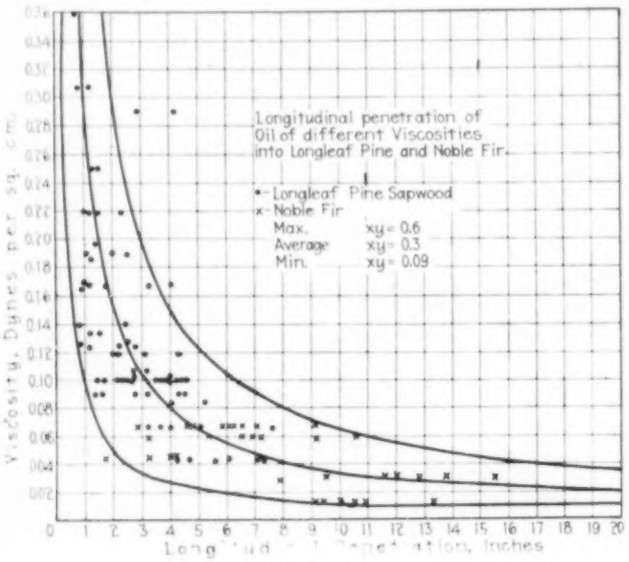

FIG. 1

indicate that for noble fir and probably for longleaf pine sapwood the equations are $yx^3 = k$ and $y\sqrt{x^3} = k$ for radial and tangential penetration respectively when the treatments are made at 75-lb. pressure for 2 hr.

There are four variables which will most certainly

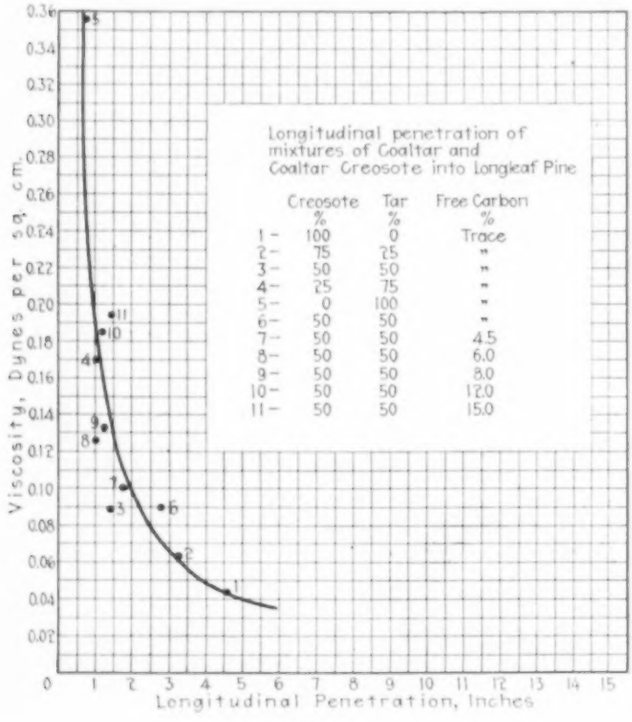
Longitudinal penetration of
mixtures of Coaltar and
Coaltar Creosote into Longleaf Pine
Creosote % Tar % Free Carbon %
1- 100 0 Trace
2- 75 25 "
3- 50 50 "
4- 25 75 "
5- 0 100 "
6- 50 50 "
7- 50 50 4.5
8- 50 50 6.0
9- 50 50 8.0
10- 50 50 12.0
11- 50 50 15.0
Viscosity, Dynes per sq. cm.
Longitudinal Penetration, Inches

FIG. 2

affect the penetration of oils in the wood. These are viscosity of the oil, the time during which the treatment is carried on, the pressure at which the oil is applied, and variations in the wood itself. This paper shows the relationship between the viscosity of the oil and the depth of penetration only when all three of the other variables are kept at the values used in the experiment: namely, 2-hr. treatment at a pressure of 75 lb. per sq.in. upon Southern yellow pine sapwood or noble fir. The effect of the other variables and their relationship to penetration is not known except in a general way. We know that in general an increase in the time of treatment increases the penetration of oil, but a penetration is finally obtained beyond which increased time has little or no effect, and the same is true of the relationship between pressure and penetrance; that is, we might expect the curve showing the relationship between penetrance and both time and pressure to take the form of a parabola. The effect of changing all three variables (viscosity, pressure, and time of treatment) at the same time is probably the product of these three equations. It is expected that further work will be done along these lines to prove out the relationship which is here shown.

Conclusions

The following conclusions can be drawn from the work:

1. That a very definite relation exists between the viscosity of the oil and the depth of penetration, and that this relation is amenable to mathematical treatment.

2. That a change in temperature of the oil has no other effect than that of changing the viscosity.

3. That the presence of free carbon in tar-creosote solutions has apparently no other effect than would be expected from the increased viscosity.

4. The following equations hold for longleaf pine and noble fir when the time of treatment is 2 hr. and the pressure 75 lb. per sq.in.

Longitudinal penetration $yx = k$
Tangential penetration $y\sqrt{x^3} = k_2$
Radial penetration $yx^2 = k_3$

where x is the penetration, y the absolute viscosity, k, k_2 and k_3 constants.

5. When the pressure and time of treatment are changed, the power of x and the value of k are changed. Sufficient data are not available to work out the effect of changes in time and pressure.

6. That the measurement of the viscosity of oils intended for treatment is perhaps the most important measurement as far as penetrance is concerned.

Inferiority of Shellac as a Glue

The highest strength value obtained in a recent series of tests where varnished surfaces were glued with casein glue was 1712 lb. per sq.in. and the lowest 1000 lb. Where shellac was used as a binder the maximum shear strength obtained was 1425 lb. per sq.in., the minimum 450, and the average 758 lb. These values indicate that shellac used as a glue is not comparable with casein or animal glues.

Melted shellac or shellac varnish should never be used for binding wood. It has been found during tests of varnished pieces that before a number could be brought to the testing machine they had fallen apart, and where they reached the machine for shearing tests the joint always broke at the joint and not in the wood. This makes it very necessary to clean wood parts which are to be glued, from all varnish or shellac before applying the animal glues.

Milling Plant of the Alaska-Gastineau Mining Co.*

Description of a Gold-Milling Plant Built in the Arctic Regions to Handle Very Low-Grade Ore—A Practicable Process Depended Upon the Low Cost of Roll-Crushing and Low Values in Slimes—Automatic Skip Hoisting in Place of Bucket Elevators Is Another Unique Feature

By E. V. DAVELER†

THE milling plant of the Alaska-Gastineau Mining Co. is located at the town of Thane, Alaska, on Gastineau Channel, four miles south of Juneau and directly across the channel from the Ready Bullion mine of the Treadwell mines on Douglas Island. Previous to the organization of the Alaska-Gastineau Mining Co., in 1912, the milling was done at the stamp mill of the Alaska Perseverance Co., located at the mine in Silver Bow Basin. But the contemplated increase in production made it necessary to locate the mill on Gastineau Channel, as not enough water was available at the mine during the winter months, nor was there room for taking care of the large tonnage of tailings that would ultimately be discarded from the mill.

Character of Ore

The gold and silver values occur in quartz lenses associated with pyrrhotite, galena, arsenical pyrites, and zinc blende. These lenses occur in large bodies of slate, schist and metagabbro, which also carry some valuable metallic contents. With the essential low cost of mining, it was necessary to mine large bodies of low-grade material containing the high-grade streaks. Of the minerals, pyrrhotite, the magnetic sulphide of iron, is predominant, and galena is the next sulphide present in quantity. The gold occurs free and coarse and associated with the iron sulphide in its finer state. The silver occurs with the lead or is alloyed with the gold. A chemical analysis of the ore shows

Silver, oz.	0.10	Magnesia, per cent.	0.4
Silica, per cent.	59.7	Sulphur, per cent.	1.2
Iron, per cent.	5.2	Lead, per cent.	0.1
Alumina, per cent.	21.4	Zinc, per cent.	0.2
Lime, per cent.	5.0		

Experimental Work

Investigations at the old Perseverance stamp mill had developed the following points:

Roughing concentration following stamping gives a fair recovery. Practically all gold values are liberated at 50-mesh. Amalgamation of the ore ground through 30-mesh yields 63 per cent of the gold as bullion. An iron concentrate could be made carrying gold and silver values. Slimes were very low in value.

While the experimental plant was being built, laboratory work developed the fact that slimes were consistently low in value, which was of great importance in the later developments of the milling operations.

In Fig. 1 is shown a flow sheet of the experimental mill. This plant had a daily capacity of 75 tons, so all tests were run on this basis in order that results might be comparable with actual milling practice. The roll capacity, of course, was greater, but the concentration department was run at normal tonnage. Machines were so placed that almost any variation desired in the flow could be made. All launders had ample grade and there was very little chance for concentration of values at any place in the mill. Headings and tailings were sampled automatically every 2 min. and hand samples were taken on the products of all machines coincident with the tonnage tests. These were then calculated back against the automatic samples for check.

As proper sampling of the ore was known to be very difficult, due to the coarse particles of gold free in the ore, the greatest precautions were taken. From laboratory tests before starting the experimental mill, it was known that grinding a large sample to 10-mesh was necessary to check results.

The heading sample was taken automatically after roll grinding with maximum size particles of 10-mesh, and on a mill run of 20 tons the heads sample amounted to 400 lb. This sample was rolled very carefully and then riffled through a Jones type sampler with a 1-in. opening. A cut of 50 lb. was obtained and the reject of 350 lb. was saved for other work. The 50-lb. sample was re-rolled and riffled to 12.5 lb., which was ground to 100-mesh and after rolling was cut to about 4 lb., for an assay sample. The 37-lb. cut was saved for screen analysis work. The 350-lb. reject from the first cut was sacked and sent to the Arthur plant of the Utah Copper Co., where check runs were made in the laboratory unit. On the average the variation of all

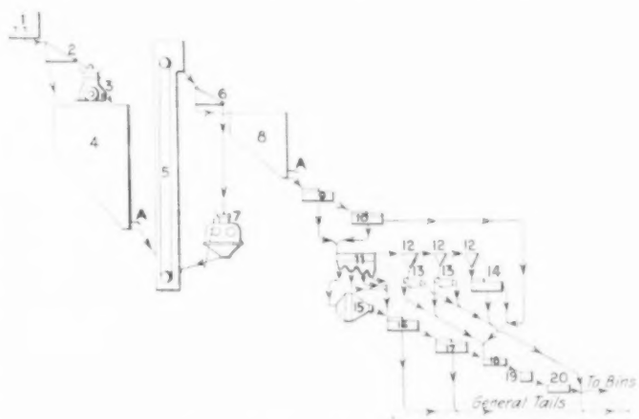

FIG. 1. FLOW SHEET, EXPERIMENTAL MILL

1. Fairbanks-Morse track scales. 2. 1¼-in. grizzly. 3. No. 1 style "D" Gates crusher; capacity 5 to 9 tons per hr. 4. Coarse ore bin; capacity 100 tons. 5. 16-in. bucket elevator. 6. Two Colorado inpact screens 3 x 4 ft.—660 shakes per min.; 12-mesh; 0.020-wire screen. 7. 42 x 16 in. Garfield rolls; r.p.m. pulley 100. 8. Fine ore bin; capacity 150 tons. 9. 4-ft. Garfield roughing table; 260 r.p.m.; ¾-in. stroke. 10. No. 6 Wilfley table; 230 r.p.m.; ¾-in. stroke. 11. Four-compartment Richards-Janney classifier; revolution shaft 80. 12. Three cone tanks; capacity, 180 cu.ft. 13. Two 6-ft. vanners; 190 shakes; 1¼-in. throw. 14. No. 3 Diester slime table. 15. Hardinge mill, 30 in. x 8 ft.; 30 r.p.m. 16. 4-ft. Garfield table; 260 r.p.m. ¾-in. stroke. 18. 4 x 8 ft. shaking plate; 1¼-in. fall; 150 r.p.m. 19. Cobbe-Middletown grinding pan; 5-ft. diameter; 50-mesh screen. 20. Stationary plate, 4 x 6 ft. A. Feeders, plunger type.

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runs in the heading assay between the Utah and Alaska results was under 5 cents on the gold assay. In assaying the nail method was used and four three assay-ton charges made on each sample, combining the resultant button for parting and weighing. In the hand-sampling work, six men were used, two sampling each day, and all six men were alternating in the work to eliminate the personal equation as much as possible.

The experimental crushing plant was started with waste to observe the effect of roll-crushing. The ore was low in moisture, running consistently under 2.5 per cent; the ore screened very readily and under ¼-in. size the slate lost its long splintery character and became cubical. The worst problem that developed in the crushing tests was the dust, which was eradicated by sprays; they were also used in the large milling plant. In the concentrating tests, the simplest methods were used first, then these were elaborated as was found necessary.

The first tests were with grinding with the rolls to varying mesh, from 6 to 16; this was followed by primary roughing on Garfield tables and cleaning the rough concentrate on Wilfley tables. Both tables were making final tailing. This method gave a recovery of 75 per cent, a tailing of $0.44, and a concentrate of $13 gold, showing a very satisfactory initial recovery, and work was followed upon tailings from this operation. Screen analysis showed that practically all the gold was liberated from the gangue with 50-mesh grinding. The tailings from the tables were then classified in the

FIG. 2. FLOW SHEET FOR COARSE CRUSHING PLANT, ROLL PLANT AND ONE 2,500-TON SECTION OF CONCENTRATING PLANT

Janney classifier, the material on 50-mesh being reground in the Hardinge mill, and the fine sands sent direct to the secondary roughing tables.

The product from the Hardinge mill was treated separately on both the roughing and the finishing machines, but with the development of the practice it was found that it could be combined with the fine sands from the classifier and treated on the roughing table, the rough concentrate being cleaned on finishing tables. Tailing made on the roughing table on the final test was $0.176; and on the finishing machine $0.32; as the tonnage of the finishing tailings was small, both roughing- and finishing-machine tailings were sent to waste.

The slime overflow from the Janney classifier, comprising about 17 to 20 per cent of the original tonnage, was very low in values, an average assay on all tests being $0.178 gold. Tests were run on this to see if an economical recovery could be made, but nothing satisfactory was worked out. It was then turned to the tail race as waste. This, of course, was one of the most satisfactory developments of the test work.

The above data show that a very economical treatment had been worked out giving high recovery at a low cost. Several check runs made with the flow sheet as adopted showed a tailing of $0.176 gold and an extraction of 89.30 per cent of the gold values. The tonnage of concentrates produced in the final check runs showed that 89.30 per cent of the gold values was concentrated into a product in the ratio of 60 to 1.

Retreatment of Concentrates

Following this, work was started on the retreatment of the concentrates. An average analysis of the concentrates was as follows:

Gold	$80.00	Magnesia, per cent	0.8
Silver, oz.	6.30	Copper, per cent	0.1
Lead, per cent	5.2	Zinc, per cent	2.7
Iron, per cent	37.3	Arsenic, per cent	0.2
Silica, per cent	12.9	Tin, per cent	0.1
Alumina, per cent	10.7	Sulphur, per cent	27.0
Lime, per cent	2.2		

The first step in the treatment was to separate the lead concentrate from the iron concentrate, which was easily done on Wilfley tables, using a finger to regulate the cut. This lead concentrate carried all the free coarse gold, a material very hard to sample. Tests showed that this lead concentrate would be separated in a ratio of 857 to 1 as to the original ore milled. The further separation of the free gold from this was left to work out later and attention was paid to the iron concentrate remaining. This iron concentrate carried from $12 to $25 gold values, some silver, and some lead.

The first work was to grind to suitable mesh and amalgamate and reconcentrate. Grinding to 100-mesh liberated the values sufficiently for amalgamation. The iron concentrate, after plating, could then be reconcentrated and a small quantity of iron-lead concentrate of high enough grade to warrant shipping could be made. The final tests showed a tailing of $1.93 gold and $0.26 silver, which with the lead concentrate would mean a shipping concentrate in the ratio of 400 to 1 of the ore milled. At the laboratory in Utah, a tailing of $0.93 gold was made with fresh concentrates; as the concentrates used at Alaska had oxidized somewhat, it was felt that the same results could be obtained in mill practice.

During the winter of 1913, laboratory tests were run at Alaska on cyaniding the iron concentrates to determine whether higher recovery could not be made. The presence of pyrrhotite made this rather difficult, but the method was finally worked out on an economic basis, giving an average recovery of 98.50 per cent of the gold values, with a 4-lb. cyanide consumption. However, the higher cost of the process was a disadvantage, so it was decided to use concentration and amalgamation on the iron concentrates.

Mill Construction

During the experimental work, which lasted until March, 1914, active construction work had been started in the large mill. By February, 1915, with the exception of the retreatment plant, enough of the mill was completed to insure starting operations. Three operating shifts were organized and on duty at the plant

for ten days before the plant started, running machinery available, so that when ore was started through there was practically no delay and the usual troubles of starting a new plant were missing. Actual mill operations were started on March 1, 1915.

Flow Sheet of the Mill

The ore from the different levels is dumped into one of the two ore-ways by 4-ton cars of the Granby type. These two ore-ways are equipped with four underswung arc gates for loading into the 10-ton cars that carry the ore to the mill. At the coarse crusher bins, the cars are spotted in groups of four and dumped by a revolving tipple (2, Fig. 2).

The ore dumped from the cars rolls down a 45 degree slope to a line of 8-in. steel I-beams spaced 10 in. apart and equipped with manganese shoes to take the wear. After over 6,000,000 tons had been dumped on these grizzlies (3), a number of the I-beams had to be replaced, because of bending, but the manganese shoes are still in service. To facilitate the sliding of the wet ore, boiler plate was used; later this was replaced by worn-out roll shells 1 in. thick, which were straightened under the steam hammer at a red heat. This makes a very cheap liner and has a very long life. The oversize from the grizzlies falls into steel bins (5) ahead of the jaw crusher, while the undersize falls into another bin (4).

The undersize from the grizzlies is fed by four 42-in. (106-cm.) wide apron feeders (6) to a stationary crimped-wire screen (9) 3 ft. (0.9 m.) wide and 14 ft. (4 m.) long set at an angle of 45 degrees with 2½ in. (6.35 cm.) openings. The undersize from this screen drops through raises (11) cut in the rock to an underground storage bin, which has a capacity of 8,000 tons. This bin was cut out of the rock during the construction period, the broken rock being crushed in a temporary plant for use as rock and sand in all the concrete used in the mill. It has thus served two useful purposes. At the bottom of the bin there is a reinforced-concrete arch over the tunnel leading to the fine-crushing department.

The oversize from the grizzlies is fed by air-operated arc gates (7) to two 36 x 42-in. (91 x 106-cm.) Buchanan jaw crushers (8) grinding to 5 in. (12.7 cm.), and discharging on 2½-in. (6.35-cm.) stationary double-crimped screens (9); the undersize of these screens drops into the underground storage bin (11). The oversize from all of the 2½-in. screens drops into four No. 8 K Gates gyratory crushers (10), which reduce the feed to pass through a 2½-in. opening. The crushers are of the gun-lock type, the mantles and concaves being of manganese steel. The lower concaves last about eight months on a 16-hr. daily operating basis. Changing the concaves and rezinking an entire set in one crusher takes 8 hr. under normal conditions.

All the crushers are belt driven from a central line shaft, which is divided into two sections so that each side of the plant is independent. The line shaft is of 5 15/16-in. cold-rolled shafting, each unit being driven by a 200-hp. General Electric motor. Mechanically controlled clutch pulleys transmit the power to the crushers through a belt drive. Electric switches are provided so that the operator can cut off power from either the gyratory or the jaw-crusher floor. This plant has a capacity of 3,500 tons in 8 hr. crushing to pass through a 2½-in. ring. The operating crew consists of a crusher man, feeder man, and oiler, per shift; one man and a helper on the day shift do all the routine repair work. Changing of concaves or mantles is done by the rigger crew when needed.

The product from the coarse crushing plant is fed from the bottom of the underground storage pocket by eight rotary feeders (12) to a tunnel conveyer belt (13), which carries it to the fine-crushing section. The rotary feeders are pulleys, 36 in. (91 cm.) in diameter with a 36-in. face, which slowly revolve and pull the ore from chutes attached to the bin bottom. The rotary feeder has a capacity of about 3,000 tons daily with the standard gate opening; different feeders are operated during each 24-hr. period to maintain an even character of ore, as there is some segregation in size in the ore pocket. These feeders are very economical to install and to maintain. After about 4 yr. service some are still in place and the cost of repairs to them has been practically negligible, and wherever possible, they are used throughout the plant. The conveyor (13) discharges ore on four all-steel impact screens (14) of the Colorado type, a modification of the standard impact screen commonly used on finer ore, but strengthened for heavy work. Four screens handle the mill feed of 10,000 tons daily, screening to a 1-in. opening. Double crimped wire screens are used and are made in the shops at the plant.

The oversize from these screens drops into a 2,500-ton bin (15) which acts as storage for the feed to the 72 x 20-in. (182 x 50-cm.) rolls (21). The undersize from the screens drops onto a 42-in. eight-ply conveyor belt (18) and is distributed by a tripper over bins (25) feeding fine impact screens (27). The oversize is fed by a rotary feeder (19) to a 36-in. rubber-covered conveyor belt (20) discharging to 72 x 20-in. rolls (21). The belt and feeders are driven from the roll shaft, insuring stopping of the feed in case rolls are stopped suddenly for any reason. These rolls crush to through 1-in. and the two sets are capable of handling oversize from a 12,000-ton mill feed daily. The product falls into the skip storage bin (22) of small capacity and is elevated by automatic skips (24) to the level of the 42-in. tunnel conveyor discharging over six impact screens. The oversize from these screens then returns to a bin ahead of the 72 x 20-in. rolls.

Elevating by Skip

The ore is hoisted by a 5-ton skip operated automatically by a 75 to 135-hp. Westinghouse hoist motor. The loading mechanism consists of an air cylinder connected to a rod, which opens the gate (23). The air is run into the cylinder through a three-way valve operated by a shaft which is rotated by the descending skip. High-pressure water is available and can be used in place of air. The time of loading is determined by an oil dashpot, which at the same time throws the master switch operating the motor. The time of loading a 5-ton skip is 11 sec., and the complete cycle of operation with two skips operated from the same motor is 1 min. 50 sec. Flat plow-steel cable ⅜ in. x 5 in. (0.95 x 12.7 cm.) is used for hoisting two skips running from the same drum, one loading while the other is dumping. The hoisting distance is 100 ft. (30 m.). This is a new feature in milling practice and replaces dry elevators very effectively. The operating and maintenance cost is quite low, the cost of maintenance being $0.009 per ton milled.

Ore from bin (25) is screened by sixty impact screens (27) of the Colorado type, making 600 vibrations per min. and equipped with 8-mesh 0.032-in. (8.3-mm.) wire-screen cloth and 9-mesh 0.028-in. (7.1-mm.) wire-screen cloth. The screens are equipped with manganese cams and tappets. The undersize from these screens falls to a 36-in. traveling conveyor (34) distributing over the fine bins (35) ahead of the concentrating department. At this point a sample of the mill heads is taken.

The oversize from the screens is conveyed by ten 24-in. (60.9-cm.) belt conveyors (23) to ten 54 x 20-in. (137 x 50-cm.) Garfield rolls (29) set to grind to 10-mesh. The feed to the rolls is sprayed to lay the dust. After grinding, the ore is hoisted by automatic 5-ton skips (32) to the 54-in. roll feed bin and screened as before. Each two sets of rolls are driven by a 300-hp. motor direct connected. The 300-hp. motor is interchangeable with the 300-hp. motor on the 72-in. rolls and the skip-hoist motors are identical with hoists (24). Conveyor and screens are driven from the 54-in. roll shafts.

A 30-ton capacity electric traveling crane operates over the floor of the fine-crushing department and over a large repair room at the end of the floor. The crane facilitates repairs, as any part of a machine can be assembled in the repair shed and then carried to its place. By having a supply of spare parts time lost can be kept at a minimum.

The ten sets of 54-in. fine-crushing rolls have a capacity of 11,000 tons daily, or 1,100 tons per roll to 10-mesh. The 54-in. roll shells give approximately 80 days' actual service and crush 96,000 tons of ore, or 17.6 tons of ore per lb. of steel in maximum operation.

Concentrator

The concentrating department is divided into four independent sections, each of which is equipped with twenty rotary feeders (36), ten primary Garfield tables (37), ten primary Wilfley tables (38), and ten four-compartment Janney classifiers (39), five tube mills (41), ten secondary Garfield tables (43), and ten secondary Wilfley tables (44). Each section then is composed of five parts, each of which can be shut down independently of the others.

The crushed product from the rolls is fed from the fine bins by rotary feeders (36) discharging into a 14-in. (35.56-cm.) launder to the Garfield tables (37). Water is here added for the first time, enough water being added to give proper consistency of feed to the tables. The launders all have sufficient slope so that water added is governed by table conditions.

Garfield tables making the first roughing concentration are double-decked tables 4 ft. (1.2 m.) wide x 12 ft. (3.6 m.) long, with riffles extending the length of the table. The head motion is of special design, very heavy and strong, as experience had shown that exceptionally heavy duty would be required. They produce a rougher concentrate, which is cleaned on Wilfley tables (38) and a tailing, which is laundered to the Janney classifiers (39).

The principle of roughing concentration, which has here been applied to gold milling for the first time, is based on the fact that the roughing table will handle a large tonnage of material per area of deck, giving a low-grade concentrate with high extraction. The low-grade concentrate can then be cleaned on a finishing table. It can easily be seen that the tonnage handled per table will materially cut down the floor space required for mill operation on a large tonnage, thus reducing construction cost and simplifying the subsequent milling operation. In fact, the success of the milling operations at this plant are due to the low cost of roll grinding and to the low cost and high efficiency of the roughing concentration.

The Wilfley tables clean the rough concentrate of the minerals present, rejecting a tailing that joins with the Garfield table tailings and is laundered to Janney classifiers. No. 5 Wilfley tables are used, but the head motion has been strengthened by increasing the size of the shaft and making the thrust bar and pitman of steel instead of iron. The concentrate from the Wilfley table is laundered to the retreatment plant. This concentrate comprises galena, pyrrhotite, sphalerite, and arsenical pyrites, all of which act as carriers for the gold.

Tailings from the primary Garfield and Wilfley tables run to four-compartment Janney classifiers (39). There are ten classifiers in a section, each classifier taking its feed from one Garfield and one Wilfley table. Each classifier, on the standard feed of 2,500 tons daily, is handling 250 tons daily. The maintenance of these classifiers is very small and one operator can look after forty classifiers and twenty tube mills. The classifier makes five products and has two main functions: one to deslime the material so that this slime, which is very low in value, can be rejected, and the other to separate the material coarser than 48-mesh for regrinding, as to liberate the values grinding to 48-mesh is necessary. In the first two spigots all material coarser than 48-mesh is dropped, the third and fourth spigots carry the sands finer than 50-mesh. The classifier overflow, which is all slimes, runs directly to the tail race. The first and second spigots discharge into a shovel or sand wheel box (40), which dewaters the feed and also discards any fine material that might be left in the feed. This combination of classifier with shovel wheel gives an excellent feed to the tube mills, as 90 to 93 per cent of the feed will remain on 48-mesh screen and about 4 per cent of over 48-mesh material passes through the third compartment of the classifier. The moisture to the tube mill is maintained at about 33 per cent.

Grinding Practice

The tube mill used (41) is a cylindrical mill 7 ft. (2.1 m.) in diameter, 10 ft. (3 m.) long, made by the Power & Mining Machinery Co. It is driven by a 75-hp. motor direct connected with a double reduction; the first reduction is through herringbone gear and pinion running in an oil bath, and the second reduction to the mill is by a heavy spur gear and pinion. Komata-type liner is used, the plates being made out of worn-out steel straightened and formed in the blacksmith shop. Lifting bars and screen are made of manganese. Each mill grinds the over-size from 491 tons daily, the product carrying about 30 per cent on 48-mesh. No return of oversize is made. Danish flint pebbles and adamant silica blocks are used for the grinding medium and, in case increase in capacity of the entire mill is made so that more than 10,000 tons is handled daily, additional tonnage can be ground in the mill by using steel balls and increasing the size of motor used. Consumption of pebbles from the beginning of operations has been 1 lb. per ton milled.

The product from the tube mills and the discharge

from the third and fourth spigots of the classifier run to secondary Garfield tables (43), each mill feeding two tables through distributor (42). These tables make a final tailing, which runs to waste. The rough concentrate from each table feeds one No. 5 Wilfley table (44), which makes a tailing to waste and a concentrate which joins the primary Wilfley concentrate and is laundered to the retreatment plant.

Retreatment Plant

From the concentrating department, the concentrates are laundered to elevator pits and carried to the top floor of the retreatment plant by a 12-in. bucket elevator (45, Fig. 3) in each half of the plant. From the elevator the concentrate is distributed to twelve standard No. 5 Wilfley tables (47), which remove a rough lead concentrate carrying all the free coarse gold. This lead concentrate is then retabled on one No. 5 Wilfley table (48) to separate the free gold from the shipping concentrate. This separates some of the coarse lead with

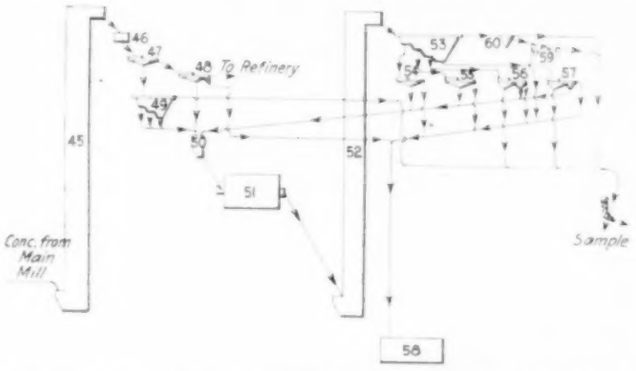


FIG. 3. FLOW SHEET, ONE-HALF RETREATMENT PLANT

practically all of the free gold, the weight of this product being about 1,000 lb. daily. It was treated at first in crucible furnaces, but is now treated in an open-hearth furnace, designed at the plant. Iron shavings are added to take up the sulphur present and the resultant products are a high-grade lead bullion and a matte. This lead bullion can be very accurately sampled and is shipped direct to the smelter.

The reject from the single table in each section handling the lead is a shipping concentrate carrying about $800 gold per ton and about 50 per cent lead. This is stored in bins (58) and shipped as often as boat sailings permit. The tailings from the twelve primary tables are dewatered into a three-spigot Janney classifier (48). The spigot discharge is then ground in a 7 x 10-ft. mill (51) to 100-mesh. After grinding the pulp is elevated (52) to a standard four-compartment Janney classifier (53). The first spigot feeds three Wilfley tables (54) and the second spigot three tables (55). These tables make a concentrate for the shipping bin (58) and a middling which returns to the tube mill (57) for further grinding. The third and fourth spigots each discharge to two tables (56 and 57), which make a concentrate to the shipping bin, a middling which returns for further grinding to the tube mill, and a tailing that goes to waste. The classifier overflow is settled in cone tanks (60) and then fed to six vanners (59), which make a shipping concentrate.

The final shipping concentrate then assays about $400 gold and 40 per cent lead, and 50 oz. of silver per ton; it is in a ratio of 1 to 1,000 of the original ore milled and contains about 44 per cent of the gold recovered, with about 56 per cent in the lead bullion. The tailings from the retreatment plant join the tailings from the concentrating mill, are sampled, and then run to the bay as waste.

Results Obtained

Following is average of series of samples throughout the plant, showing the results of the various concentrations of gold values:

General heads	$1.250	Tube-mill feed	.490
Primary Garfield tailings	.347	Tube-mill discharge	.490
Primary Garfield concentrates	13.150	Secondary Garfield tailings	.170
Primary Wilfley tailings	.844	Secondary Garfield concentrates	5.450
Classifier feed	.523	Secondary Wilfley tailings	.460
First spigot classifier	.600	Secondary Wilfley concentrates	5.360
Second spigot classifier	.320	General concentrating tails	.177
Third spigot classifier	.260	Retreatment tails	1.000
Fourth spigot classifier	.260	General tails	.200
Classifier overflow	.160		

The average value of the concentrate going into the retreatment plant is about $70 gold per ton; and after the initial lead concentrate is made, iron concentrate which is reground and treated is left, assaying $19 per ton. After treating a tailing of $1 is made.

TABLE I. GENERAL HEADS

	Mesh	Per Cent Material	Cumulative per Cent Material	Assay	Per Cent Value	Cumulative per Cent Value
Plus	10	2.5	2.5	$0.83	1.5	1.5
Plus	20	27.7	30.2	1.24	24.6	26.1
Plus	28	21.0	51.2	1.45	21.8	47.9
Plus	48	5.7	56.9	3.10	12.7	40.6
Plus	65	5.6	62.5	3.72	15.0	75.6
Plus	80	3.2	65.7	1.24	2.8	78.4
Plus	100	3.7	69.4	1.86	4.9	83.3
Plus	150	5.9	75.3	0.83	3.5	86.8
Plus	200	1.7	77.0	1.03	1.3	88.1
Minus	200	23.0	100.0	0.72	11.9	100.0
		100.0		$1.39	100.0	
			General Tails			
Plus	20	1.48	1.48	$0.15	1.18	1.18
Plus	28	9.08	10.56	.15	7.22	8.40
Plus	48	10.43	20.99	.21	11.60	20.00
Plus	65	12.59	33.58	.26	17.34	37.34
Plus	80	8.08	41.66	.26	11.13	48.47
Plus	100	8.88	50.54	.26	12.23	60.70
Plus	150	7.95	58.49	.26	6.32	67.02
Plus	200	7.17	65.66	.15	5.70	72.72
Minus	200	34.34	100.00	.15	27.28	100.00
		100.00		$0.19	100.00	
			Retreatment Tails			
Plus	65	2.70	2.70	$0.41	1.29	1.29
Plus	80	1.45	4.15	.52	0.88	2.17
Plus	100	9.55	13.70	.62	6.88	9.05
Plus	150	32.95	46.65	.72	27.58	36.63
Plus	200	4.35	51.00	.93	4.70	41.33
Minus	200	49.00	100.00	1.03	58.67	100.00
		100.00		$0.86	100.00	

Characteristic screen analyses of the mill heads, mill tailings and retreatment tailings are as shown in Table I, Tyler standard screen sieves being used.

Results

The work has shown that economic grinding of the ores for final concentration is through 48-mesh; that the slimes carry very low values; and that regrinding and concentration of the iron concentrate will liberate the gold values, permitting the iron to be thrown away. This, of course, reduces the smelting costs and losses to a minimum. Also, the lead concentrate produced carries 40 per cent lead, which is a good smelting product.

Concentrates are sacked and shipped to the Selby Smelting Co. for treatment. At the beginning of operations we were using amalgamation as an additional process in the retreatment of our concentrates but found this unnecessary.

Great pains are taken at the mill to insure accurate sampling of all vital products. For the headings to the concentrating departments, the undersize from each screen is sampled automatically and cutters ½ in. (12.7 mm.) wide are operated by a Scobey timing device throwing the four-way air valve connected to the air cylinder. A cut is taken every 12 min. and samples are collected every 24 hr. On a basis of 6,000 tons of ore milled, the combined sample averages about 3,000 lb., or ½ lb. per ton milled. This is carefully coned and ringed several times and then quartered, opposite quarters being saved together and about a 50-lb. sample cut from each of the two cuts by additional ringing and coning. These then are ground to 700-mesh in the laboratory and riffled to assay pulp size, weighing about 4 lb. each.

The assayer runs four charges of two assay-tons each on each sample, combines the resultant silver-gold buttons, and then parts and weighs them together. The average of the original and the duplicate is then taken as the average for the day.

The stream of tailings from each half of the mill is cut by an automatic sampler every 10 min. operated as for the head sample. These samples, amounting to 150 lb. each, are collected at the end of every shift. They are rolled and riffled, a 10-lb. sample from each shift sample being put through the pulverizer and ground to 100-mesh. From each of these shift tailing samples, the assayer runs four samples, each of three assay-tons, making a total of twelve crucibles for the three tailing samples.

Concentrate production is sampled automatically and at the time of shipment an auger sample is taken from each sack. Special sampling of different products throughout the plant is kept under way at all times.

Costs of Operation

While the plant has not treated its full tonnage, the results of operating in the year 1917, when for a period the tonnage was maintained at 7,023 tons, gives an idea of what costs will be under full operating basis. These costs are as follows:

Coarse crushing	$0 02804	Labor cost	$0 09746
Fine crushing	.09432	Supplies	.05454
Concentrating	.05136	Shop expense	.03787
General mill	.02778	Sundries	.04970
Power and light	.01467		
General overhead	.02340	Total	$0 23957
Total	$0 23957		

Potash Statistics

The following statistics, from German official sources, quoted by the *Fortnightly Information Review* of the American Chamber of Commerce in France, show the foreign and domestic sales of German potash salts, K_2O.

Year	Domestic Sales, Tons	Foreign Sales, Tons	Total, Tons	Value in Marks Calculated on Legal Prices	Value in Dollars at Par	Percentage Used in Agriculture	Percentage Used in Industry
1910	460,618	346,473	807,091	133,800,000	$31,800,000	88.3	11.7
1911	527,822	441,941	969,763	160,100,000	38,100,000	90.5	9.5
1912	581,422	524,514	1,105,936	186,400,000	44,400,000	89.5	10.5
1913	664,711	556,695	1,221,406	202,500,000	48,200,000	90.4	9.6
1914	591,590	402,797	994,387	164,500,000	39,200,000	91.2	8.8
1915	623,807	123,947	747,754	111,700,000	26,600,000	92.0	8.0
1916	797,548	174,825	972,373	163,900,000	39,000,000	94.1	5.9
1917	958,625	146,084	1,104,709	230,500,000	54,900,000	95.7	4.3

The statistics in Table I of the consumption of actual potash—K_2O (German)—in agriculture, not including industry, in the most important consuming countries, are also taken from German official sources. The quantity is given in short tons.

Durability of Cement Drain Tile in Alkali Soil

After an interruption of two years, due to the pressure of war work, the field inspection and testing in connection with the drain tile in alkali soils has again been taken up by the Bureau of Standards, Department of Commerce. In Minnesota, pieces of tile which have been in the ground since the last inspection have been removed for test and the concrete was found to be uninjured either by alkali or acids, but a number of both the best and poorest tile was found to be cracked. It is thought that some time during the cold weather water had backed up and stood in the pipe, freezing and bursting it. A complete survey of all the most important reclamation projects in the West is to be made in the near future, and based on this work the committee in charge of the investigation will endeavor to make definite recommendations relative to the manufacture and use of cement tile in alkali soils. The results of the work already accomplished are embodied in the Bureau's Technologic Paper T95, "Durability of Cement Drain Tile in Alkali Soil."

TABLE I. CONSUMPTION OF POTASH (K_2O) IN AGRICULTURE

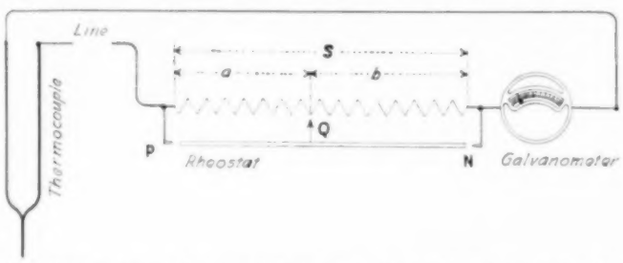
Country	1910 Tons	1911 Tons	1912 Tons	1913 Tons	1914 Tons	1915 Tons	1916 Tons	1917 Tons
Germany	395,269	464,575	509,722	589,713	531,990	572,232	748,617	917,820
Belgium	9,886	10,011	12,040	14,501	11,408	11,742	11,670	15,878
Holland	32,338	37,812	43,421	47,826	46,188	31,972	62,535	48,225
France	25,134	29,115	34,860	36,426	21,327	65	1	1
United Kingdom	20,084	22,992	25,756	25,572	12,792	.....	.....	.....
Luxemburg	118	193	312	442	511	1,632	1,800	2,384
Austria	12,996	16,572	20,767	23,072	23,404	18,611	27,820	32,724
Hungary	1,477	3,019	4,110	4,508	3,210	2,835	3,514	3,018
Switzerland	3,055	2,945	3,851	3,639	4,438	2,785	7,556	5,206
Italy	6,161	6,667	8,025	6,990	4,880	521	.....	.....
Russia	16,003	18,787	25,762	24,920	16,883	1,424	3,972	1,097
Spain	8,083	10,830	9,910	9,122	3,502	252	.....	.....
Portugal	870	1,244	1,248	1,365	455	60	.....	.....
Sweden	18,290	19,197	22,737	21,465	26,671	24,909	24,968	30,536
Norway	1,937	2,511	3,774	3,953	5,271	3,967	4,379	30,536
Denmark	4,804	6,195	6,607	8,222	8,212	8,553	18,260	30,536
Finland	1,080	1,459	1,565	1,766	684	.....	.....	.....
Balkan States	152	414	408	218	806	200	53	.....
Asia	3,531	5,137	6,406	6,281	4,633	707	38	40
Africa	1,808	2,523	3,455	4,807	2,126	121	.....	.....
United States	139,063	206,141	233,446	254,859	167,749	5,551	.....	.....
Canada			307	1,513	337	.....	.....	.....
Remainder of North and South America	8,345	7,467	8,614	10,140	7,271	.....	.....	.....
Australia	1,996	1,970	2,883	2,739	1,187	.....	.....	.....

Simple Pyrometer Adjustment

IN THE practice of pyrometry it is often difficult to bring about in the student's or user's mind an adequate appreciation of the several variables and electrical quantities to be considered. It is decidedly easier to teach the operator to read a galvanometer type instrument than to train him to employ a potentiometer or balancing type of meter. Quite often he is more impressed with the simplicity of the direct reading instrument than he is with its errors, with the result that the potentiometer, or adjusting type of instrument, suffers by comparison in his judgment.

As has been shown by many writers, resistance is the most uncontrollable source of error. It is therefore highly desirable, if this source of error is to be eliminated with the user's full appreciation, to teach him to measure it or compensate for it. A circuit described by Dr. E. F. Northrup in the current *Pyrolectric Bi-Monthly Bulletin* may be simply explained as follows:

In the accompanying figure an ordinary rheostat is placed in series in circuit. The resistance of the galvanometer is ordinarily known, being stamped on the instrument, and may be represented by the letter G.



Similarly the total resistance of the rheostat is designated by S, while the unknown resistance of thermocouple and line is called x. The problem is first to discover the value of the resistance of the entire circuit when in operating order.

Proceed as follows: Place the thermocouple in a hot furnace at equilibrium, close switch N and open P; then move the sliding contact Q on the rheostat to the left until the resistance a is zero and the deflection D of the meter is at its maximum. This gives the same meter reading for the temperature in question as though the line were connected directly to the galvanometer in the usual way, without rheostat in circuit and the total resistance, which may be called R_1, is $G + x$.

$$R_1 = G + x \qquad (1)$$

This deflection D is noted, and without changing the switches, move slides Q to the right until sufficient additional resistance a has been thrown in circuit to reduce the deflection by one-half. Galvanometer now reads $\frac{D}{2}$, the total resistance through which the current is passing is $G + x + a$ and may be called R_2, or

$$R_2 = G + x + a \qquad (2)$$

Now, without disturbing the slides Q, reverse the switches, opening N and closing P. The resistance, R_3, of the entire circuit, including galvanometer, line, rheostat and thermocouple, after this adjustment exactly equals S, the total resistance of the rheostat.

This is easily proved as follows:

Since adding resistance a to the circuit cut the deflection of the galvanometer in half, by that evidence it cut the current flowing in half. Now, since the applied electromotive force generated by the thermocouple is constant, it being held at uniform temperature, if the current is cut in two it was because the resistance of the circuit was doubled. Hence $R_2 = 2R_1$

Substituting from equations (1) and (2)

$$G + x + a = 2(G + x)$$

Simplifying $$a = G + x \qquad (3)$$

But the final course of the current is from thermocouple through line and switch P to slides Q and thence through resistance b to the galvanometer. Neglecting as before the resistance of the rheostat bar between P and N, the total resistance of the adjusted circuit equals the sum of the resistance of thermocouple, line, galvanometer, and coil b. In symbols

$$R_3 = x + G + b$$

but from equation (3) $G + x = a$. Hence, substituting

$$R_3 = a + b$$

By definition of a and b, they are the component parts of the rheostat, so that $a + b = S$. Or,

$$R_3 = a + b = S$$

In other words, the resistance of the adjusted circuit is equal to that of the total rheostat, which was what we set out to prove.

As remarked at the outset, variable resistance in thermocouple and line are responsible for the chief uncertainty in direct reading instruments. Here, then, is a simple method, where merely by a rheostat and a double throw switch, it is possible to correct a galvanometer for all errors due to line drop or extraction of current from high resistance shunt. When it is desirable to confirm any stationary needle reading, it can be done very quickly as follows: Reverse switches, run slide to zero, note deflection, draw deflection down one-half by sliding back contact Q, reverse switches, and check dial against former reading. The thermocouple resistance and the galvanometer resistance are measured in terms of the current sensitivity of the galvanometer, a factor that is practically constant, having a very slight change with temperature. It is believed to be a new method whereby the measurement of resistance is accomplished and expressed in terms of the galvanometer "current constant."

The relative error of setting is small in direct proportion as $b + x$ is small in comparison with g. Also the error of setting for $\frac{D}{2}$ is inversely increased with the reduction in the value of D.

Much has been written relative to the errors involved in the use of a galvanometer for measuring thermocouple electromotive forces. In general, it may be said that accuracy with a galvanometer is secured only at the sacrifice of durability, unless manual adjustment is made in the operation of the instrument to overcome the errors of resistance and resistance changes. The pyrovolter and the potentiometer both require manual adjustment for every reading, readings being taken on a "null" method.

It is believed that the circuit described will assist in impressing on operators the various sources of trouble in a thermocouple circuit and their relative importance and will suggest a method for overcoming them.

The following characteristics of this circuit may be of interest. Maximum allowable resistance in thermocouple circuit external to instrument is $M = s - g$. The emf. range of the instrument is given by $E = SI$, where I is the current required to deflect the galvanometer to full scale.

Legal Notes

By Wellington Gustin

Manufacturer and Seller of Tool Steel Warrants His Product—"High-Speed" Steel Not a Trade Name

THE uniform sales act has been adopted in most of the states. All sales contracts made therein must be construed according to decisions interpreting its provisions. The Supreme Court of Pennsylvania recently had occasion to pass upon a New York sales contract, the goods having been sold f.o.b. the point of shipment in New York to a manufacturer in Pittsburgh, Pa.

The Reliance Steel & Tool Co. of New York sold to the Metal Product Co., manufacturer in Pittsburgh, certain high-speed steel for the making of tools. When the steel arrived it appeared to be in good condition, but after expenses had been incurred by the manufacturer in its attempt to make the tools, it was found unfit for the purpose, or any other manufacturing purpose, and only valuable as scrap iron. Thereupon the buyer refused to pay. The seller brought suit for goods sold and delivered. (107 A., 713.)

Matters Involved in the Dispute

Upon trial of the cause there was no question raised as to the quantity of steel received, nor as to prices and credits allowed. There were three matters involved in the dispute, as follows: Was the steel of a quality reasonably fit for the making of tools? Was there an express warranty it should be so fit? And was there an implied warranty it should be reasonably fit for the purpose, because of seller's knowledge of the purpose for which it was purchased? Now, the seller admitted he knew the purpose for which the steel was purchased. The trial court gave judgment for the seller, and the buyer appealed to the Supreme Court, which reversed the judgment in the case.

Provisions of the Sales Act

On the appeal the last of the three questions was the important one to be determined. Its proper answer lay in the following provisions of the sales act, which provides:

"Where a buyer, expressly or by implication, makes known to the seller the particular purpose for which the goods are required, and it appears that the buyer relies on the seller's skill or judgment (whether he be the grower or manufacturer or not), there is an implied warranty that the goods shall be reasonably fit for such purpose. . . .

"In the case of a contract to sell or a sale of a specified article under its patent or other trade name, there is no implied warranty as to its fitness for any particular purpose.

"Where there is a breach of warranty by the seller, the buyer may, at his election, (*a*) accept or keep the goods, and set up against the seller the breach of warranty by way of recoupment in diminution or extinction of the price.

Measure of Damages for Breach of Warranty

"The measure of damages for breach of warranty is the loss directly and naturally resulting, in the ordinary course of events, from the breach of warranty.

"In the case of a breach of warranty of quality, such loss, in the absence of special circumstances showing proximate damage of a greater amount, is the difference between the value of the goods at the time of the delivery to the buyer and the value they would have had if they had answered to the warranty."

Supreme Court Holds That "High-Speed Steel" Is Not a Trade Name

The trial court held that "high-speed steel" is a trade name under the section above, and hence there was no implied warranty as to its fitness for any particular purpose. The Supreme Court said this was erroneous. There was evidence as to what constituted high-speed steel, and that each manufacturer thereof had a separate and distinct trade name for the particular high-speed steel manufactured by him. The generic name of an article made by several is not a trade name.

The seller was permitted to produce evidence of an alleged general custom in trade—contradicting the provision of the sales act quoted above—to the effect that, if a buyer discovers defects in high-speed steel, his only right is to return it and receive credit for the contract price. This was error, the court held.

Further, it held to be error to refuse to permit the buyer to show the expense incurred in the endeavor to make tools from the steel, before it discovered the impossibility of so doing. This objection was based on the provision above which says a buyer is entitled to set off only "the loss directly and naturally resulting in the ordinary course of events," which, "in the absence of special circumstances showing proximate damage of a greater amount, is the difference" between the value of the steel as it was and as it would have been had it "answered to the warranty." The court said it is difficult to understand what loss could more directly and naturally result, in the ordinary course of events, than the initial expenses incurred in using the steel, when the defects in it were not discoverable otherwise. That such expenses are allowable, if not too remote, has often been decided, both before and since the passage of the sales act.

It was contended by the seller that there was no implied warranty in the sale that the goods were fit for the purposes sold. Before the uniform sales act was passed the courts had held repeatedly that there was such an implied warranty so far as relates to the grower or manufacturer of the goods sold, and the only change made in the rule by this act was to extend it to include every seller, "whether he be the grower or manufacturer or not."

Law Implies Seller's Warranty of the Product

In an earlier case (28 L. Ed., 86) the Supreme Court of the United States said on this point:

"When, therefore, the buyer has no opportunity to inspect the article, or when, from the situation, inspection is impracticable or useless, it is unreasonable to suppose that he bought on his own judgment, or that he did not rely on the judgment of the seller as to latent defects of which the latter, if he used due care, must have been informed during the process of manufacture. If the buyer relied, and under the circumstances had reason to rely, on the judgment of the seller, who was the manufacturer or maker of the article, the law implies a warranty that it is reasonably fit for the use for which it was designed; the seller at the time being informed of the purpose to devote it to that use."

The Demand and Supply of Fixed Inorganic Nitrogen in the United States

A Concise Review of Our Present and Future Needs of Nitrogen and of the Advantage Resulting in the Continuous Operation of the Government Nitrate Plants to Help Supply Industrial and Agricultural Requirements

By ALFRED H. WHITE

THE United States uses fixed nitrogen for three main purposes—food, fertilizer, and chemical manufacture. The first two items are linked together, for the nitrogen fixed in foods is drawn from the soil, and provision must be made for the soil's replenishment. Provision for the increased food supply which this country needed during the war was hampered by lack of nitrogenous fertilizer. The increased cost of farm labor, and the increased value of crops, as well as the constant impoverishment of the soil, all point to the use of fertilizers in areas where they have not previously been used and their more liberal use on fields where they have formerly been used. It is safe to assume that nitrogenous fertilizers will be used in progressively increasing measure during the next decade at least.

One branch of the chemical industry of the country—that of explosives—was enormously stimulated during the war and has dropped down to approximately pre-war levels. The use of commercial explosives may be expected to grow with the development of the various industries in which they are used. Certain industries, notably the dye industry and those connected with the manufacture of artificial leather, photographic films, celluloid and other products of nitrated cotton, are requiring vastly increased amounts of nitric acid. These industries are still infants and may, if properly encouraged, be expected to grow materially faster than the average manufacturing industry of the country.

Organic and Inorganic Nitrogen

There are two fairly well recognized divisions of fixed nitrogenous products—organic and inorganic. The organic products are typified by tankage, dried blood and other products from the slaughter houses, and by the oil cake and hulls from the cotton plant. These products formerly went mainly to fertilizer, but in more recent years have been diverted more and more into food for cattle. Within a few years almost all of the oil cake and a considerable part of the high-grade tankage will be diverted away from fertilizer. The amount of organic nitrogen available for fertilizer is therefore decreasing and certainly no increase in it can be expected. The inorganic nitrogen compounds divide themselves into two broad classes—nitrates and ammonia compounds. These are not strictly interchangeable in either the fertilizer or the chemical world, but fortunately they are exchangeable to a considerable extent, and ammonia compounds are also convertible to nitrates, so that the world can increase its stock of either form in the full confidence that it will be used. The ammonia compounds of this country come almost entirely from the coke ovens and gas works. A relatively small amount comes from cyanamide obtained by fixation of atmospheric nitrogen at one plant at Niagara Falls. The nitrates come exclusively from Chile, on the west coast of South America.

Fixed Nitrogen as a Basis for Calculation

Since the United States can use both ammonia and nitrates, it is simpler, for purposes of study, to make all calculations in terms of fixed *nitrogen*, without reference to its source as ammonia or nitrate. Since the supply of organic nitrogen available for fertilizers is actually decreasing, it is clear that any increase in the amount of fixed nitrogen used by the chemical or fertilizer industries must come from inorganic sources.

The attached chart shows graphically the consumption of inorganic fixed nitrogen by the United States from 1902 to 1918, together with possible future developments. The development from 1902 to 1915 is fairly normal. The next four years reflect the war conditions and are so abnormal that they should not be considered in plotting future demand.

Future Demand for Fixed Inorganic Nitrogen

The graphs for the total consumption of inorganic nitrogen show an increase of nearly 200 per cent in the decade 1902-1912. The fluctuations are too great to permit any exact curve being traced, but the increase is very nearly linear and increases at the rate of 9,100 tons of nitrogen a year. If this line is projected to 1930, it shows a consumption of 300,000 tons of inorganic nitrogen for that year as indicated by line *E* of the chart. This is certainly low, for a flat increase of 9,100 tons means a decreasing rate which will have dropped to only 3 per cent annually at the end of this period. This could hold true only if the agricultural and chemical fields were becoming saturated. The contrary is the case, for the chemical industries of the country are growing rapidly, and the agricultural field, having not yet appreciated the economic advantage of nitrogenous fertilizers, will be only beginning to realize the full advantage of a more liberal use of fertilizer by that date.

It is therefore safe to assume a progressive increase in the total demand for nitrogen. Two graphs for this have been constructed, one portraying a 10 per cent cumulative annual increase, commencing with 1902 (line *G* of the chart), and the other a 7 per cent cumulative annual increase starting with a normal figure of 145,000 tons of inorganic nitrogen in 1913 (line *F* of the chart). The curve of 10 per cent increase lags throughout the pre-war period, and it is not certain that it indicates too rapid increases in the post-war period, although it does lead to rather startling figures. If the United States should continue to use fixed inorganic nitrogen at a cumulative 10 per cent annual increased rate, it would require, in 1930, 676,000 short tons of nitrogen, which,

translated to terms of nitrate, corresponds to 3,900,000 long tons of Chilean nitrate, more than twice as much as this country imported even under the stress of war and 25 per cent more than Chile can produce. If a 7 per cent cumulative increase is adopted as being more probable, it points to a total demand in 1930 of 458,000 tons of inorganic nitrogen, which, if supplied entirely from Chile, would require 2,600,000 tons of nitrate, which is nearly Chile's maximum output.

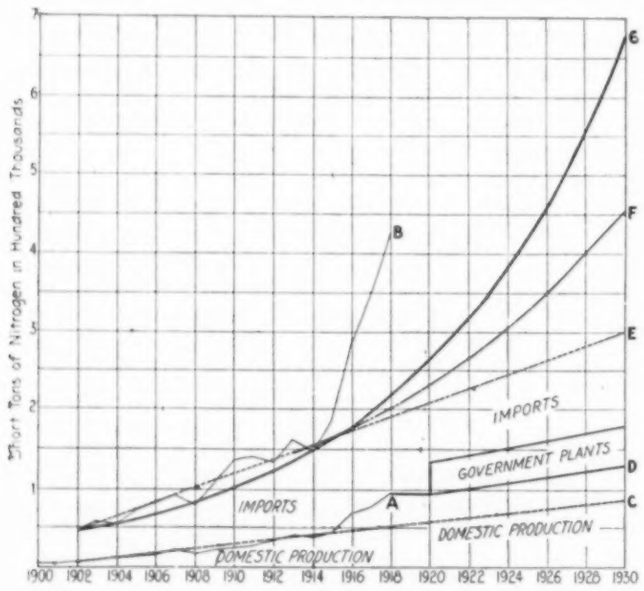
Of course it will not all be imported from Chile. Much of it will be produced at home, as ammonia compounds, and some may be imported as ammonia salts from European nations. The situation in 1913 is shown more fully in Table I.

The figures for nitrogen supply are all taken from the tables in the American Fertilizer Handbook, most of which are derived from official Government reports. The figures for utilization of sodium nitrates are taken from the report of the Federal Trade Commission (Senate Document 551, 64th Congress) on the Fertilizer Industry. The Commission received reports from six informants in close touch with the nitrate situation, whose averaged estimates for 1913 are as follows:

	Per Cent	Tons of Chilean Nitrate Based on 626,000 Tons Imports
Explosives	39.2	245,400
Fertilizers	45.5	284,800
Chemicals, etc.	15.3	95,800

The figures for utilization of ammonia are from an unpublished Government estimate.

The chart shows that the production of fixed inorganic nitrogen in the United States rose steadily in the



INORGANIC FIXED NITROGEN TOTAL CONSUMPTION OF UNITED STATES

A and *B*. Total domestic production and imports for 1918.

C. Total estimated domestic production up to 1930 on the assumption of an annual increase of 2,800 tons, beginning 1902 (approximately normal previous to war).

D. Total estimated domestic production up to 1930 on the assumption of an annual increase of 3,700 tons after 1920.

E. Total estimated demand up to 1930 on the assumption of an annual increase of 9,100 tons (approximately normal during the decade 1902-1912).

F. Total estimated demand up to 1930 on the assumption of an annual cumulative 7 per cent increase over normal 1913 consumption.

G. Total estimated demand up to 1930 on the assumption of an annual cumulative 10 per cent increase over 1902 consumption.

TABLE I. STATISTICS FOR FIXED INORGANIC NITROGEN FOR U. S. IN 1913

1913 Supply of Fixed Inorganic Nitrogen[1]	Nitrogen Short Tons
Chilean nitrate, 626,000 long tons	109,000
Imported ammonium salts calculated as sulphate = 65,775 short tons sulphate	13,550
Domestic production of ammonia from coke ovens and gas works calculated as sulphate = 195,000 short tons sulphate	40,200
American Cyanamid Co. 15,000 tons cyanamide	3,000
	165,750

1913 Utilization of Fixed Inorganic Nitrogen		Nitrogen Short Tons
Imported Chilean Nitrate[2]		
Fertilizer	245,400 long tons[2]	
Explosives	284,800 long tons	
Chemicals, glass, etc.	95,800 long tons	
	626,000 long tons[1]	
	701,000 short tons	109,000
Ammonia:		
Sulphate for fertilizer	130,000 tons	26,800
Cyanamide	15,000 tons	3,000
Ammonia for essential industries		30,000
		168,800

[1]The American Fertilizer Handbook.
[2]Report on Fertilizer Industry by Federal Trade Commission, Senate Document 551, 64th Congress.

period 1902 to 1915, but not so fast as the demand of the country, so that in the latter years of the period the importations were twice as great as in 1902. Even the great growth of the coke ovens during the war has failed to bring the American production of inorganic nitrogen up to within 100,000 tons of the normal demand. The curves show that if all the imports were from Chile there would, on a normal basis, have to be at least 600,000 tons of nitrate imported in 1920.

Future Domestic Production

The future domestic production depends largely on the byproduct coke ovens. Their rapid increase during the war has increased the production of byproduct coke so that in normal times approximately two-thirds of the coke will probably be produced in byproduct ovens.

The future increase in coke ovens will probably correspond somewhat closely to the growth of the pig iron industry, which takes by far the larger part of the coke made. The growth of pig iron production was almost exactly 50 per cent between 1905 and 1915. It will probably not increase so rapidly in the next decade. The assumption is therefore made that the production during the years 1919 and 1920 will be the same as in 1918, and that 1930 will show an increase of 40 per cent over 1920 in pig iron, and byproduct coke-oven coke and its resultant fixed nitrogen. This is shown on the chart as line *D*. It will be seen that it falls far short of meeting the fixed nitrogen demands of the country.

Future Fixation of Atmospheric Nitrogen

The two lines of fixation of atmospheric nitrogen which were largely developed during the war were the cyanamide and the Haber processes. Neither of them affords any definite promise of profitable *commercial* operation in this country in the near future. The cyanamide process requires too much electrical energy and the Haber process needs further study and development before it can be considered a commercial success. Nevertheless this country cannot afford to fall behind in the development of nitrogen fixation. The Chilean nitrate supplies are waning and sooner or later reliance will have to be placed on fixation processes.

Utilization of Government Plants

Fortunately, the United States Government is well fitted to carry on the work of nitrogen fixation. It has

in its Nitrate Plants Nos. 1 and 2 exemplifications of the two main types of processes. The cyanamide plant is of superior design and can be operated as a Government plant to produce fertilizer at a cost which will pay running expenses at the lowest price which fixed nitrogen is likely to reach, due to the fact that it has very cheap electrical energy, which will be produced at its hydro-electric plant at Muscle Shoals. It should return some interest to the Government on the investment. These plants should certainly be operated. When working at full capacity they will fix 50,000 tons of nitrogen a year. As shown by the chart, this is still entirely inadequate to meet the prospective demand. The figures are given more fully in the Tables II, III and IV.

TABLE II. FORECAST OF DEMAND AND SUPPLY OF FIXED INORGANIC NITROGEN IN U. S. FOR 1920

Demand:		
Based on a normalized figure of 145,000 tons (as shown by the chart) in 1913 with an assumed normal increase of 7 per cent compounded annually. Factor for 7 per cent for 7 years = 1.60.		
		Nitrogen Short Tons
Total demand, 145,000 × 1.6		232,000
Sources of Supply:		
Coke ovens, gas ovens and plant of American Cyanamid Co., estimated as same as 1918		92,700
Balance to be made up		139,300
Possible production from U. S. Nitrate Plant No. 2		41,500
Balance to be imported		97,800
Importations to be made up by Chilean nitrate or foreign ammonium sulphate:		
	Per Cent of Total Supply to be Imported	Chilean Nitrate Equivalent in Long Tons
If Government nitrate plants are operated	42.1	508,000
If Government nitrate plants are not operated	60.4	710,000

TABLE III. FORECAST OF DEMAND AND SUPPLY OF FIXED INORGANIC NITROGEN IN U. S. FOR 1925

Demand:		
Demand based on 1913 normalized figures from chart with increase of 7 per cent compounded annually. Factor = 2.25.		
		Nitrogen Short Tons
Total demand 1925 = 145,000 × 2.25		326,000
Sources of Supply:		
Domestic coke ovens, gas ovens and private cyanamide plants with assumed increase of 20 per cent over 1920		111,240
Balance to be made up		214,760
Possible production from U. S. N. P. Nos. 1 and 2 41,500 + 8,500		50,000
Balance to be imported		164,000
Importations to be made up by Chilean nitrate or foreign ammonium sulphate:		
	Per Cent of Total Supply to be Imported	Chilean Nitrate Equivalent in Long Tons
If Government nitrate plants are operated	50.5	947,000
If Government nitrate plants are not operated	66.0	1,234,000

Effect of Government-Owned Plants

As shown by the chart and the accompanying tables, there need be no fear that the present Government nitrate plants can in any way flood the market. They will serve to decrease the reliance which must be placed on Chilean or foreign sources and they will serve as a focus from which knowledge of the fixation art may be spread abroad through the country. Improvements may be expected from their research laboratories, and inventors of new processes will be assured of sympathetic assistance. The plants certainly will maintain themselves without expense to the Government and will return a dividend to the Government on its investment. If the future price of inorganic nitrogen rises at all proportionately to the price of other commodities, the net earnings should be considerable. The effect of the Government plants in reducing importations on the basis of the 7 per cent cumulative increased demand already discussed is shown in the following table:

TABLE IV. FORECAST OF DEMAND AND SUPPLY OF FIXED INORGANIC NITROGEN IN U. S. FOR 1930

Demand:		
Demand based on normalized 1913 figures from chart with increase of 7 per cent compounded annually. Factor = 3.16.		
		Tons
Total demand 1930 = 145,000 × 3.16		458,200
Sources of Supply:		
Domestic coke ovens, gas ovens and private cyanamide plants with assumed increase of 40 per cent over 1920		130,000
Balance to be made up		328,200
Possible production of U. S. N. P. Nos. 1 and 2		50,000
Balance to be imported		278,200
Importations to be made up by Chilean nitrate or foreign ammonium sulphate:		
	Per Cent of Total Supply to be Imported	Chilean Nitrate Equivalent in Long Tons
If Government nitrate plants are operated	60.7	1,600,000
If Government nitrate plants are not operated	71.6	1,900,000

ESTIMATED PERCENTAGE OF INORGANIC NITROGEN REQUIREMENTS WHICH MUST BE IMPORTED

	Government Nitrate Plants in Operation	Government Nitrate Plants Idle
1920	42.1	60.4
1925	50.5	66.0
1930	60.7	71.6

Surely, with the lessons of the war still fresh in mind, this country cannot afford to count on the importation of more than one-half of the inorganic nitrogen, vital both for munitions and fertilizers. Unless the Government plants are operated and fixation processes encouraged, two-thirds of our inorganic nitrogen must be imported in the near future.

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Ann Arbor, Mich.

Sodium Fluoride as a Wood Preservative

Tests made years ago indicated that sodium fluoride might successfully be used as a wood preservative because it had high toxicity, was not injurious to metal and was convenient to handle. Laboratory tests alone, however, are never sufficient to establish the value of any material as a wood preservative; actual service tests, even though they require years to complete, are also needed.

In order to obtain comparative durability records, the laboratory in 1914 placed sap-pine ties treated with sodium fluoride, together with ties treated with zinc chloride and creosote, in one of the mines of the Tennessee Coal, Iron & Railway Co., at Birmingham, Ala. Similar service tests were also started at this time on red oak ties placed in the tracks of the Baltimore & Ohio R.R. Co.

After five years of service the mine ties which were treated with sodium fluoride have been found in as good condition as those treated with zinc chloride, both showing very little deterioration. The creosoted mine ties apparently were in still better condition, while the untreated ones were in various advanced stages of decay. The red-oak railway ties treated with sodium fluoride were practically all sound, as were those treated with zinc chloride, whereas a large percentage of the untreated oak ties had been removed.

Both of these tests, as well as others started later, must continue for a number of years yet before the relative value of the sodium-fluoride treatment for ties and timbers is definitely known.—*Abstract from Forest Products Laboratory "Technical Notes."*

Caustic Pot Settings

By F. G. Wheeler

THE process of making caustic soda and chlorine as a step in the manufacture of other compounds has become widespread in the last decade. In many of these the chlorine is used on the spot and the caustic soda is sold. The final operation before placing the caustic soda upon the market is its concentration from a sirupy solution to the fused condition which is accomplished by boiling it in a large open vessel or "caustic pot" until no more water remains in the liquid. In this condition the fused caustic soda is finished by heating red hot, and as it cools it is allowed to settle. When the freezing point is reached, it is conveyed to sheet-steel drums, in which it solidifies, and in this condition is shipped.

The "caustic pot" is a large semi-spherical vessel of cast iron. The common form is one in which the depth of the pot is about 70 per cent of the diameter. Various sizes are used, a common one weighing about thirteen tons and discharging from eighteen to twenty tons of caustic soda per batch. It is supported by a concrete column and is heated from a furnace using either coal, wood, gas or oil for fuel.

Furnace Requirements

The design of the furnace has never been standardized, each engineer using what seemed to him the best for the purpose. This practice has resulted in many different designs, for each one of which is claimed various advantages.

The chief objects in designing such a furnace, besides the obvious one of the ability to finish the caustic, are economy in operation, long life for both the furnace and the pot, an arrangement which will automatically enable an ordinary workman to finish the caustic, and finally, protection against severe damage to either furnace or setting in case of pot failure.

The first two requirements are readily obtained by following boiler-furnace practice. The art of building boiler furnaces has reached such a general high state of perfection, and the principles which govern it are so familiar to boiler operators, that a furnace adapted to caustic-pot operation can easily be designed.

Economical Conditions

Economy can best be obtained by securing high furnace temperatures. The simplest way of accomplishing this result is to build a furnace only large enough to finish the caustic when it is forced to work at a high rate of combustion per sq.ft. of grate surface. The fireman must then keep his grates covered and work a thin fire in order to make the pot boil and "finish" the caustic on time. The result is a high furnace temperature and consequent economy of operation. As with boiler furnaces, care must be exercised in not creating a furnace temperature so high that the ash, in the particular coal which is used, will form clinker and plug the grates, but as high a temperature as possible under local conditions should be maintained.

The second condition leading to economy is the arrangement of the ash pit. This should hold a small amount of water so that steam will be formed and will pass with the air through the grate, rotting the clinker and keeping the grates free. The use of shaking grates will assist materially in this work.

The third factor for economy is the use of a combustion chamber behind the grate, before the hot gases are chilled by the pot. This allows the soot to be burned and produces a minimum amount of smoke. It may be obtained by building a deep bridge wall behind the grates, which allows the necessary distance through which the flames may pass for combustion before reaching the pot. An extra convenience for the fireman, where coal is the fuel, is the arrangement of the bridge wall so that the fireman can place his fire upon it while cleaning the grates. The old fire can then be drawn forward to start the new fire without inconvenience.

The final consideration leading to economy is the arrangement of the flue around the pot. No hot gases should pass from the furnace to the stack without coming in contact with the pot. The flue should be narrow and arranged with baffles to direct and hold the gases close to the pot, and so prevent them from passing too quickly up the chimney.

The writer prefers a three-battery setting, using two fusing pots and a preheating pot. This arrangement causes gases to pass around the fusing pot and then into contact with a preheating or "back" pot which is set higher than the fusing pot. The liquor in the back pot is heated before flowing into the front pot. The flues around the back pot should also be baffled so that the gases from one fusing pot do not antagonize those from the other pot.

A few minor details make for economy, such as the use of a damper in the flue between the pots, the scraping of the fusing pot free from soot and ashes, and the cycle by which one pot of a battery is worked with the other one to keep the feed liquor from the back pot the hottest when needed.

Conditions for Low Furnace Depreciation

Long life of both the furnace and the pot is very essential in caustic finishing work. Long furnace life is obtained by using good brick and setting them properly. Only the best grade of firebrick should be used. These can be obtained in most shapes so that the furnace can be built for the hardest work and the highest temperatures. An arch made of wedge brick set on end gives the longest life. A semi-circular arch allows for expansion and contraction better than a sprung arch. Buckstays properly located permit the arch to expand and contract without injury to the side walls, and make the furnace a compact, well-built device for meeting the best operating conditions. In locating the furnace in front of the fusing pot, care shou'd be taken to prevent the working floor from resting on the arch or the side walls of the furnace. The weight and the vibration from anything passing over the floor should not be conveyed to the arch, which should be free to respond to furnace conditions only.

Conditions for Low Pot Depreciation

Long pot life is obtained by protecting it from any blow-torch effect of the flames as they leave the furnace. The thick cast-iron wall of the pot will not respond to the cooling from the liquor inside as a boiler tube does. By placing a firmly set guard wall at the back end of the bridge wall in front of the pot, the flames may be made to come in contact with the pot gradually so that they will do it no injury. The guard wall should be thin. A thick, heavy guard wall holds and reflects the heat back into the furnace and

does not adapt itself to expansion or contraction. The reflected heat warps the grates and the furnace door, as well as burns the fireman's hands. Such a wall will crack easily. It also occupies the space which should be used for combustion in the furnace. The guard wall should also be arranged to support the inner end of the arch which rests upon it.

The caustic pot should be arranged so that it can be turned easily from time to time and so present a fresh surface to the flames at the sides of the guard wall. A pot regularly turned about every thirty charges will have a long life without further attention.

Other Operating Hints

Only a few points remain for an engineer to bear in mind. Sufficient draft should always be available and the baffles should be arranged in such a way that the passage of the gases to the chimney are not excessively large. All that the fireman should have to do is to keep a good fire until the finishing heat is reached, when the damper can be closed and the pot allowed to cool slowly, permitting all of the impurities to settle out.

The bottom of the pot should be protected from the heat so that, as the settlings reach the bottom, no currents of molten caustic will carry the settlings back into the clear portions of the liquid. This can be done with the same material which protects the supporting column and which makes the flue floor by filling well up around the bottom of the pot.

If a failure occurs from a crack or a sand hole, it sometimes happens that the molten caustic will leak out, dissolve the cinder or the sand filling below the setting and work its way down and under the foundation. For this reason the writer prefers to place a slab of concrete under the entire battery rather than only the amount required for supporting the load. This concrete, if it be made of granite gravel, will present an effective barrier to the molten liquid, and will prevent it from destroying the support under the foundation.

Caustic furnaces and settings which have been built in the manner outlined above have eliminated many difficulties. The caustic soda can be finished regularly with less than 1,000 lb. of coal per ton of caustic. A furnace will last for fifty or more charges with no repairs, and many caustic pots now in service have poured more than two hundred batches of caustic soda.

Bleach Process Co.
Appleton, Wis.

The Caking of Sulphate of Ammonia*

By C. G. Atwater and J. F. W. Schulze

Sulphate of ammonia, as usually produced, has shown a tendency to cake when stored in bags or in a pile. This has been ordinarily attributed to the presence of 1 to 2 per cent moisture and to a small amount of residual sulphuric acid from the saturator. This caking tendency is of little importance when the material is used in mixed fertilizers, as the sulphate is easily broken up in the usual processes of handling and mixing. When sulphate of ammonia is to be used by itself, as a separate fertilizer or top dressing, as is the intention with the dried and screened article recently placed on the market, the mechanical condition is a critical point and any tendency to cake must, if possible, be eliminated.

The obvious method of preparation is to dry the salt in a current of hot air and to screen out small lumps and nodules. This method at first seemed to be effective and produced an article that was fine, dry and readily spread by hand or agricultural machines, providing the moisture was less than 0.25 per cent. As the manufacture extended to additional plants, however, it was found that the product of some of them when brought well below 0.25 per cent moisture, showed a lack of condition; would not run freely in a drill and was more liable to cake on storage. In order to determine the cause of this trouble and to eliminate it, the investigation which the present paper describes was made.

Laboratory Examinations

A number of representative samples of ammonium sulphate were collected and two selected for examination. No. 1 was chosen as typical of those that did not absorb moisture on standing and did not cake, and No. 2 as typical of those that remained moist to the touch and tended to cake.

In No. 2 some pyridine was present, this being noticeable by smelling of the hands after squeezing a handful. Pyridine was also detected in No. 1 in the same manner, but a markedly smaller amount was present.

Free Pyridine Bases

At first it was thought that free pyridine bases were the cause of the moisture in the samples, but this was disproved when pyridine dissolved in ether was mixed with some of the No. 1 material. After the evaporation of the ether, pyridine escaped from the sulphate till it was as dry as before the application.

Hot air was passed through a drying tower containing No. 2 sulphate and when this was exposed again to the air it still became moist and turned red.

Both No. 2 and No. 1 samples were now placed under pressure of 200 lb. per sq.in. for 24 hr., to see if caking were caused. In the case of the former a slight lumpy condition resulted, but the No. 1 sulphate was scarcely affected by the pressure.

The estimation of the pyridine present was undertaken by the following method: There was weighed out 25 g. of $(NH_4)_2SO_4$ into a liter round bottom flask, about

TABLE I. ANALYSES

	Total Bases Per Cent	Free Bases Per Cent
No. 2	0.281 0.275 0.276	0.162 0.192
No. 2 exposed to air	0.220 0.224	
No. 2 dried 9 hr. with hot air	0.148 0.150	0.098 0.112
No. 1	0.039 0.039	

250 c.c. of water added and when solution was complete 5 c.c. N NaOH was added. This was immediately connected to a flask containing NaBrO solution, thence leading through a splash bulb to a condenser. When the first flask was boiled, the NH_3 liberated was oxidized to nitrogen by the NaBrO, the pyridine passing through unchanged and being collected in N/10 H_2SO_4.

After considerable experimental work Congo red was

*A paper read before the Fertilizer Section at the Philadelphia meeting, Sept. 2-6, 1919, and published by permission of the American Chemical Society.

selected as the most suitable indicator for the titration with N/10 alkali. At the best the end point was very poor, and only by titrating back and forth several times could a fairly accurate end point be obtained.

The bases as they are liberated near the end point are partly insoluble in water and form a sort of emulsion which makes difficult an accurate determination.

The results in Table I have been calculated on the basis of pure pyridine.

It is quite evident from the results on free bases that considerable hydrolysis of the pyridine sulphate takes place in solution. In each pair of analyses the second one was purposely boiled a little longer than the first and hence gave a higher result, as was to be expected.

Also even in the air pyridine is liberated from $(NH_4)_2SO_4$ samples, which are actually acid already. The method of testing the acidity of sulphate is simple titration with alkali. A large part, if not all, of this acidity is due to the presence of pyridine sulphate.

As an example of the degree of acidity that pyridine sulphate is capable of assuming, especially in heated solution, the following test stands out: To 25 c.c. N/10 H_2SO_4 was added an excess of light pyridine. This solution was allowed to evaporate on the steam bath until no distinct odor of pyridine was obtained. On diluting and adding Congo red it required about 15 c.c. N/10 NaOH to produce an alkaline reaction. The weakness of this base and the consequent hydrolysis of its salts in solution is also shown by adding an excess of it to a N/10 acid solution containing indicator. It will give a distinct acid reaction even in the presence of a large excess of pyridine over the theoretical amount required to react with the acid present. Only by the addition of an enormous excess can an alkaline reaction be shown with Congo red.

Miscellaneous Impurities

Qualitative tests were made on the two samples of sulphate, and besides the pyridine bases, iron and chlorine were found in small amounts. A small precipitate appeared with bromine water with the No. 2 sulphate. This was taken to indicate the presence of phenols, especially since a nitrophenol odor was produced on boiling with dilute HNO_3. $FeCl_3$, however, gave no color to the solution.

Since the No. 2 sulphate turned red in the air, contrary to the behavior of the No. 1, it was thought that phenols were the cause of this phenomenon. But when crude phenols in ether solution were mixed with No. 1 sulphate and the ether allowed to evaporate no red color appeared. The phenols slowly evaporated and left the sample as dry as before.

Some of the No. 2 sulphate was extracted with benzol and ether after removing the water present by boiling with benzol. A small amount of resinous material and some pyridine were found. After extracting at least twelve times and allowing to stand in the air, the sulphate again became moist and turned reddish brown. A sample of this was treated with dry NH_3 gas and remained dry on standing, with no color change.

It now occurred to us that pyridine sulphate might be the cause of the sample taking up moisture; so a small amount of H_2SO_4 was added to some No. 1 sulphate and a pyridine ether solution, stirred in until all the ether had evaporated. Then on standing in the air the material became moist and also assumed the reddish color of the exposed No. 2 sulphate.

Further, several samples of the No. 2 class of sulphate, including No. 2 itself, were treated with cold dry NH_3 gas and after a few minutes became quite dry to the touch, remaining so indefinitely in the air.

Pyridine[1] is likewise readily liberated from the $(NH_4)_2SO_4$ by washing the latter with saturated liquor containing a small amount of NH_3. When 250 g. of sulphate was washed with 150 c.c. solution containing about 0.3 g. NH_3, the pyridine content was reduced from 0.380 per cent in the original to 0.180 per cent in the final product. This is identical to the amount of pyridine in the ammonia gas-treated material.

From these results it is quite apparent that the cause of the moist feeling and consequently of the caking of $(NH_4)_2SO_4$ samples is pyridine sulphate, other impurities being negligible in effect.

Pyridine Sulphate the Cause of Caking

The impurity in $(NH_4)_2SO_4$ is therefore recognized as pyridine sulphate. This causes the sample to feel moist to the touch and due to its presence in the sulphate the latter will take up moisture on damp days, only to lose it later with the decreasing humidity of the atmosphere to produce a decided caking effect. The amount of water taken up, as well as the resultant caking, is in proportion to the amount of pyridine sulphate present.

By passing dry NH_3 gas through samples containing pyridine sulphate, pyridine is liberated and passes off. If the NH_3 is preheated, quicker and more thorough results are obtained. A treatment of the sulphate with very dilute ammonia liquor produces practically the same effect, and in some cases would be more practical commercially. Ammonium sulphate may be produced by either of these simple methods freed of a major part of its original pyridine content. In this state it will not absorb an appreciable amount of moisture from the air and its caking will be negligible.

The Barrett Co.,
New York, N. Y.

[1]See "Recovery of Pyridine From Byproduct Coke Ovens," CHEM. & MET. ENG., vol. 22, No. 6, pp. 274-5.

Truck With Regenerative Braking

After a number of years of research in the field of light-weight, low-cost electric vehicles, Dr. Charles P. Steinmetz has recently announced the development of a light-weight electric truck, one of the principal features of which is the method of motor control, which gives the motor compound characteristics by a storage cell floating on the field circuit.

The result of this method of control, Dr. Steinmetz pointed out, is speed maintenance, quick starting, power saving in the field at large currents and the feature of regeneration both on down grades and on stopping.

The field and armature of the motor revolve in opposite directions, each driving one of the car wheels. In this way motor weight is saved, the differential is eliminated and the truck is simpler and more compact.

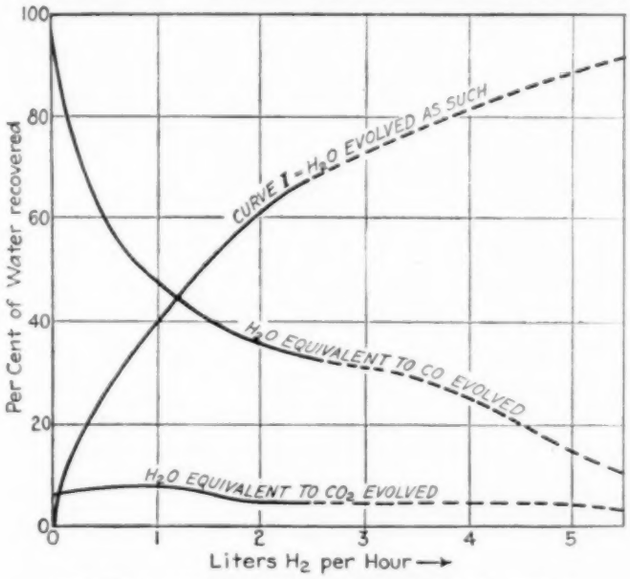
By saving in motor weight and in battery weight, by the elimination of differential and in other ways a lower-weight truck is obtained. The ½-ton truck, without body, for instance, will have a weight, it is stated, of only 2,300 lb.

As a result of the above features and with the use of standard parts, it is claimed that lower operating cost and lower price will result.—*Electrical World*, vol. 75, p. 341, Feb. 7, 1920.

Synopsis of Recent Chemical and Metallurgical Literature

Limitations of Ledebur Method for Oxygen in Steel.—In Bureau of Standards Scientific Paper No. 346, J. R. CAIN and EARL PETTIJOHN present a study of oxygen content of Boylston's ingots (*Carnegie Scholarship Memoirs*, vol. 7, p. 102) and ingots of a series of bessemer rail-steel heats made at the Bethlehem Steel Co.'s Sparrows Point plant. In both of these studies acid converter metal was deoxidized by various substances, such as spiegel, ferromanganese, ferrosilicon, ferrotitanium and aluminum, and the oxygen content determined by the Ledebur method as modified by the authors (see Bureau of Standards Technologic Paper No. 118).

There seems to be no relationship between the Ledebur oxygen and various methods of deoxidation in the ladle, the aluminum treatment in the molds or the effect of rolling, the analytic results for steels of approximately the same chemical composition varying in a vague manner up to 0.020, sometimes approaching even 0.030. Ledebur oxygen, therefore, probably



GENERATION OF H_2O, CO AND CO_2 AT 900 DEG. C.

has no relation to efficiency of deoxidation, probably because the slag oxides resulting from the additions trapped in the solid metal do not yield their oxygen in this method. Neither is annealing *in vacuo* for a given time and temperature, nor determining nitride nitrogen adequate for a study of deoxidation.

In order to study the reasons for this failure on the part of the reputable Ledebur method, CAIN and L. ADLER (Bureau of Standards Scientific Paper No. 350) studied the various reactions which may proceed during the determination, i.e., when heating a steel (iron, carbon and iron oxide) to 900 deg. C. in a stream of hydrogen of various speeds. Using a mixture of iron oxide and graphite, all the oxygen in the ore could be recovered as water.

That is, the reaction

$$FeO + H_2 = Fe_2 + H_2O$$

proceeds practically to completion without interference by $FeO + C \rightarrow Fe + CO$ which Falcke says starts at about 600 deg. C.

However, when a mixture of iron oxide and cemented iron or cast iron was heated under a given gas stream, the amount of oxygen recovered as water fell off as the amount of iron-carbon alloy increased; that is, iron carbide has now partially reduced iron oxide. On studying a mixture which contained a ratio of ferrous oxide to combined carbon as 1 is to 5 (which was thought to approach extreme conditions occasionally found in steels) and varying the rate of hydrogen current, results plotted in the accompanying figure were found.

Since curve I showed such a large deficit in oxygen as water, additional studies were made in order to determine whether the other gases were CO, CO_2, and saturated hydrocarbons. The last proved to be very small, while the carbon oxides are plotted in the figure.

Reactions $FeO + C \leftrightharpoons Fe + CO$

and $FeO + CO \leftrightharpoons Fe + CO_2$

should tend to produce larger amounts of CO with increasing hydrogen rate, but since this condition was not found experimentally, it is thought that these reactions are not much affected at 900 deg. C. Thermal dissociation of carbon monoxide

$$2CO \leftrightharpoons CO_2 + C$$

should be shifted to the left with more rapid hydrogen passage. A result in conformity to that found

$$CO_2 + H_2 \leftrightharpoons CO + H_2O$$

tends toward the right at 900 deg., so a rapid current by sweeping quickly into a cool spot will suppress production of CO. Reaction

$$C + H_2O \leftrightharpoons CO + H_2$$

is the one most affected, being shifted to the left, according to expectations. The figure shows that under the experimental conditions holding for Ledebur's method no more than 75 per cent of the reduction of ferrous oxide can be affected by hydrogen (temperature, 900 deg. C., carbon : ferrous oxide = 5 : 1; and hydrogen rate 3 liters per hr.)

Switzerland Factory Statistics in 1918.—The report of the Swiss Department of Public Economy published in the November, 1919, issue of the *Swiss Exporter* gives the statistics for the number of factories and employees in Switzerland in 1918, arranged according to industries. There were 9,327 establishments and 381,170 employees working under the factory acts. The figures for the various industries are as follows:

Industry	No. of Establishments	Employees — Male	Employees — Female	Total
Cotton	313	8,585	17,458	26,043
Silk	211	6,788	23,478	30,266
Wool	66	2,585	4,111	6,696
Linen	31	411	945	1,356
Embroidery	828	7,932	14,923	22,855
Other textile industries	129	1,430	3,183	4,563
Clothing and outfitting	1,031	11,279	24,890	36,169
Foods and table luxuries	791	13,573	13,614	27,187
Chemical industries	270	14,230	3,534	17,764
Power stations	276	4,705	8	4,713
Paper	700	12,798	6,105	18,903
Woodworking	1,325	21,954	910	22,864
Metals	902	30,961	5,582	36,543
Machinery	842	61,986	3,817	65,803
Watches and jewelry	1,222	25,376	21,099	46,475
Mineral materials	390	11,817	1,153	12,970
Total	9,327	236,410	144,760	381,170

From 1913 to 1918 the number of factory employees has gone up from 341,295 to 381,170, an increase of about 40,000; the increase is most notable in the machine, metal, watch and chemical industries. There has been a decrease in the number of employees in the

textile, paper, wood, food and mineral industries. In 1918 39 per cent of all factory employees in Switzerland were employed in the machine, watch, jewelry and metal industries; of the total number 38 per cent were females.

Acid-Resisting Metals.—The December, 1919, issue of *Chemie et Industrie* contains an extensive description of acid-resisting metals by Prof. C. MATIGNON. With the exception of a short description of ferroborides, the article treats of ferrosilicons. He gives their historic beginning with the work of Jouve, enumerates the different alloys used for acid-resisting containers used in France, Germany, Great Britain and America, and describes their properties (fusibility, density, conductivity, magnetism and chemical resistance). The study of the chemical resistance of the industrial ferrosilicons was made in collaboration with Miss Momal. They studied the action of nitric acid and the mixture of acetic and butyric acid on Metillure, Elianite I, Elianite II, Ironac, Duriron and Tantiron, for different periods of boiling. The results are tabulated. The article contains also a review of the uses of some of the alloys in the manufacture of apparatus for the heavy chemical industry.

Influence of Chemical Composition and Thermal Treatment Upon the Properties of Iron Alloys.—E. GUMLICH and P. GOERENS publish in the *Elektrotechnische Zeitschrift* of June 26, July 3, 10, 17 and 24, 1919, their report upon the results of experimental investigations into the properties of pure iron alloys which have been carried out in Germany for ten years or so under the co-operation of several scientific institutions and metallurgical concerns. Most of the measurements were made at the Reichsanstalt, hand in hand with metallographical studies conducted by WÜST and GOERENS. Suitable samples with systematically varying percentages of C, Si, Al and Mn were carried through certain thermal and magnetical cycles, and extensive sets of data for each condition of the material were obtained. By extrapolation from the curves for the several series of alloys there were obtained, as probable averages, the following data for pure iron: Specific gravity, 7,876 g. per cu.cm.; specific resistivity, 0.0994 ohm per min., sq.mm. at 20 deg. C.; temperature coefficient, 0.00573 per 1 deg. C.; magnetic saturation, 21,620 max. per cu.cm. The effects of annealing upon the magnetic properties of commercial transformer plate were thoroughly investigated, the results leading to the conclusion that the annealing causes a decided deterioration, the effect being worse the higher the temperature. During the first few hours, however, a net improvement is obtained, due to mechanical softening of the material and expulsion of gases, and the effects preponderate over the deterioration due to the annealing. Maximum improvement was observed in from 4 to 24 hr., and 785 deg. C. (1,440 deg. F.) appeared to be the most favorable annealing temperature.

Japan's Foreign Trade.—The January, 1920, issue of the *Trans-Pacific* gives, in statistical form, the quantity and value of the principal commodities imported and exported during the first nine months of 1919. Figures for the corresponding period of 1918 are given for comparison. Tables I and II present a summary of the figures given for products of interest to the chemical and metallurgical industries.

TABLE I. EXPORTS OF CHEMICALS, ETC., FROM JAPAN

	Nine Months Ending Sept. 30			
	1919		1918	
Articles and Countries	Quantity Kin (1.33 Lb.)	Value Yen ($0.4985)	Quantity Kin	Value Yen
Camphor:				
Total	1,525,275	5,070,684	1,493,973	3,083,555
United States	1,176,028	3,608,214	496,829	901,189
Colza (rapeseed) oil:				
Total	6,983,095	2,869,407	15,459,439	5,275,606
United States	3,698,835	1,474,447	13,068,538	4,525,098
Great Britain	1,651,944	714,800	136,935	41,239
Copper, ingot and slab:				
Total	28,375,824	17,096,596	41,048,833	28,522,298
China	20,379,717	12,448,710	7,569,454	5,585,267
France	238,769	143,966	11,819,970	8,097,310
Fish oil and whale oil:				
Total	8,056,092	2,299,921	15,797,459	3,003,245
United States	798,233	262,188	6,321,725	1,271,144
Great Britain	4,214,903	1,243,814	6,111,346	1,010,494
Belgium	1,541,008	372,284	.....	.....
Glass and manufactures:				
Total	.....	12,874,305	.....	11,366,889
United States	.....	1,179,533	.....	898,327
Menthol crystals:				
Total	190,977	1,875,363	208,344	1,288,469
United States	129,958	1,256,715	66,802	416,635
Great Britain	45,707	425,956	109,630	664,123
Pottery:				
Total	.....	14,969,891	.....	14,660,875
United States	.....	3,697,295	.....	3,704,400
Sugar, refined:				
Total	93,280,359	16,867,570	132,522,082	16,109,609
China	81,608,081	14,539,166	114,561,959	13,882,586
Sulphur:				
Total	37,038,868	1,536,337	73,660,663	2,816,921
Australia	19,019,024	660,066	49,176,150	1,617,913
Zinc ingot and slab:				
Total	8,885,499	2,757,786	26,728,369	8,477,153
Great Britain	6,439,942	2,103,156	5,953,398	1,988,131
France	.....	.....	11,852,182	3,516,281

TABLE II. IMPORTS OF CHEMICALS, ETC., INTO JAPAN

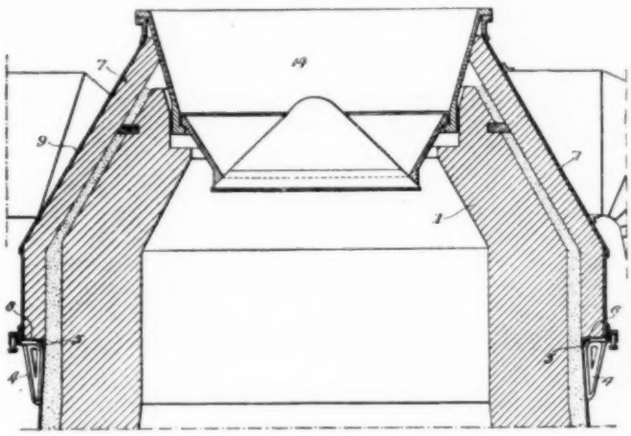
	Nine Months Ending Sept. 30			
	1919		1918	
Articles and Countries	Quantity Kin (1.33 Lb.)	Value Yen ($0.4985)	Quantity Kin	Value, Yen
Ammonium sulphate, crude:				
Total	460,363*	7,439,519	11,368*	189,669
Antimony:				
Total	3,094,639	522,569	9,159,900	2,124,394
China	3,094,639	522,569	9,159,886	2,124,390
Brass and bronze:				
Total	508,734	118,771	2,347,210	730,993
Caustic soda and soda ash:				
Total	99,311,647	9,748,059	68,994,199	9,493,916
United States	43,687,914	5,693 898	45,341,855	7,516,888
Great Britain	55,122,916	4,027,016	23,292,117	1,955,532
Dyes, coal-tar:				
Total	1,517,199	8,244,054	1,474,170	8,704,524
United States	1,059,200	6,076,910	981,363	4,962,748
Switzerland	326,803	1,443,207	105,822	450,662
Germany	28,770	151,193	345,893	3,007,789
Iron (lump, ingot, bloom, billet and slab):				
Total	349,488,804	42,653,692	261,956,631	39,697,972
United States	65,052,785	8,279,689	28,131,178	5,279,412
Iron (bar, rod plate, sheet, wire, etc.):				
Total	563,584,846	106,683,083	685,951,757	161,181,439
United States	484,450,202	91,170,563	662,762,640	154,347,096
Iron (pipe and tube):				
Total	39,627,163	10,125,025	46,466,075	10,926,390
United States	37,094,250	8,996,433	43,907,063	10,216,756
Kerosene oil:				
Total	24,971,677†	14,252,622	19,228,327†	6,625,200
United States	20,119,835†	11,842,377	17,065,227†	6,030,551
Lead (ingot and slab):				
Total	27,601,369	5,571,359	40,470,428	9,783,005
United States	8,026,195	1,329,201	15,831,293	3,723,802
Australia	17,454,274	3,870,828	22,419,954	5,512,726
Leather:				
Total	1,220,431	3,688,949	1,075,539	2,462,879
United States	817,565	2,293,150	632,540	1,644,745
Nickel (ingot and grain):				
Total	2,194,794	3,192,279	648,282	841,622
United States	1,880,666	2,783,039	478,093	665,890
Oil cake:				
Total	19,285,379*	98,994,640	15,660,575*	69,592,908
China	5,179,160*	28,267,094	2,956,129*	13,569,819
Kwantung Province	11,645,930*	57,972,566	9,948,934*	43,836,492
Paper:				
Total	.....	14,266,207	.....	5,774,344
United States	.....	12,517,457	.....	4,746,704
Paper pulp:				
Total	38,684,592	5,842,079	33,446,455	4,694,705
United States	20,196,973	3,002,999	9,631,481	1,462,503
Canada	16,784,795	2,481,557	21,558,153	2,883,281
Rubber and gutta-percha, crude:				
Total	14,878,156	13,775,042	7,346,028	8,599,703
Straits Settlements	14,237,937	12,768,442	6,734,545	7,722,170
Sodium nitrate, crude:				
Total	84,500,728	10,560,470	67,511,897	9,446,183
Chile	83,489,612	10,488,738	66,832,568	9,393,918
Tanning extracts:				
Total	4,692,224	869,193	5,307,805	1,172,188
United States	317,097	73,610	83,333	9,731
Argentina	1,200,990	188,237	1,241,670	301,862
Dutch India	1,415,023	221,584	1,926,831	426,200
Tin (ingot and slab):				
Total	4,036,363	5,598,543	3,868,421	6,475,553
Straits Settlements	2,909,088	3,948,065	2,603,452	4,252,570

* Picul (133⅓ lb.) † Gallons.

Recent Chemical and Metallurgical Patents

Complete specifications of any of the United States patents may be obtained by remitting 10c. each to the Commissioner of Patents, Washington, D. C.

Blast-Furnace Top.—EDWIN G. RUST, of Philadelphia, Pa., has patented the blast-furnace top shown in the figure, so designed that the main furnace lining 1 is carried full height at maximum thickness, and the dome lining is supported entirely outside of the shell, being supported by brackets 4 and angle iron 5



BLAST-FURNACE TOP

riveted to the steel plate. Horizontal ring 6 is riveted to angle iron 5, but held down to the brackets only by loose bolts, so that thermal expansions and contractions may be reflected by a limited vertical movement of the outer part of the ring, the dome lining 7 and the hopper 14, all acting as a unit. (1,307,884; June 24, 1919.)

Rust Prevention.—JAMES H. GRAVELL, of New York City, notes that it is difficult to remove the last traces of the liquid, non-volatile phosphoric acid in which steel parts are immersed for rust proofing. Especially is it necessary to remove the last traces when the rust-proofed pieces are to be painted. He suggests that a saturated solution of oxalic acid in water be used instead. The pieces upon drying are then covered with finest crystals of solid acid, over which paint can be placed with no damage to its adherent qualities or permanency. In case oily metal is to be treated, 30 per cent by volume of an organic solvent such as alcohol is added to the bath. (1,315,017; Sept. 2, 1919.)

Sodium Ferrocyanide.—When a mixture of one part of coke with four parts of barium carbonate is heated in a suitable retort for about 6 hr. while a current of nitrogen is passed through the mass, the product obtained has approximately the following composition: $Ba(CN)_2$, 25 per cent; $BaCN_2$, 3; BaO, 23; $BaCO_3$, 35; C, 14. After grinding, the material is leached with hot water, yielding a solution of cyanide, cyanimide and hydroxide of barium. Treatment with sodium carbonate precipitates the barium as carbonate and forms the corresponding sodium salts. The cyanide is changed into ferrocyanide by heating the solution to 80 deg. C. with finely divided iron, and the hydroxide converted to carbonate by passing in carbon dioxide. In order to separate the sodium carbonate and sodium ferrocyanide by fractional crystallization, TEOFRON BOBERG, of London, England, takes advantage of the fact that the maximum solubility of sodium carbonate is coincident with the transition point at about 36 deg. C. Accordingly, the solution is evaporated to incipient crystallization at 80 deg. C., and then cooled to about 36 deg. C., when the ferrocyanide separates substantially free from carbonate. The mother liquor when cooled further gives crystals of sodium carbonate which are used again in the process. (1,318,258; assigned to Techno-Chemical Laboratories, Ltd., London, England; Oct. 7, 1919.)

Bismuth.—Concentrates containing 80 to 95 per cent of bismuth, with varying amounts of sulphur and tellurium, are heated to about 1,700 deg. F. A portion of the S and Te volatilizes, while a slag forms which may be stripped by cooling to about 1,200 deg. F. On reheating, the presence of S and Te is indicated by a purple tint on the surface of the molten metal. These impurities may be removed by treating with 5 to 10 per cent of $CaCl_2$ or $MgCl_2$. The chlorine volatilizes iron impurities, while the calcium or magnesium combines with the S or Te. (1,318,335; ELTON R. DARLING, assignor to Ellis-Foster Co.; Oct. 7, 1919.)

Sodium From Sodium Chloride and Calcium Carbide.—At temperatures between 1,200 and 1,300 deg. C. a mixture of calcium carbide and sodium chloride gives off vapors of metallic sodium which may be recovered in a suitable condenser. According to HORACE FREEMAN, of Niagara Falls, Ont., the reaction probably proceeds in two stages:

$$2NaCl + CaC_2 = CaCl_2 + Na_2C_2$$
$$Na_2C_2 + \text{heat} = 2Na + 2C$$

Obviously, other alkali metals may be made by the same process. (1,319,148; assigned to American Cyanamid Co.; Oct. 21, 1919.)

Oxidation of Methane to Formaldehyde.—Natural gas or other gas with high CH_4 content is mixed with two volumes of nitric oxide and a volume of air or oxygen sufficient to convert the nitric oxide into nitrogen peroxide. The gaseous mixture is then passed through a red hot porcelain tube. In order to prevent further decomposition or oxidation of the formaldehyde formed, REGINALD K. BAILEY, of Lawrence, Kan., suggests the following procedures: (*a*) The gases are quickly cooled by passing through water containing $CaCO_3$ in suspension. The $CaCO_3$ tends to unite with the oxides of nitrogen, except nitric oxide, thus preventing the formation of nitric acid; (*b*) the hot gases may be passed over a dehydrating agent such as CaO, whereby the water formed during the reaction is absorbed and the formation of nitric acid or nitrous acid prevented. Were these acids permitted to form, they would oxidize the formaldehyde to carbon dioxide and water. (1,319,748; Oct. 28, 1919.)

Use of Niter Cake in Diazotization.—Niter cake (sodium bisulphate) furnishes a cheap source of acid for the liberation of nitrous acid from sodium nitrite in the process of diazotization. In addition, the sodium sulphate formed acts as a precipitant for the compound formed after coupling. ELMER K. BOLTON, of Wilmington, Del., cites the following example of this use for niter cake: Aniline (60 g.) is converted into aniline sulphate by the addition of 51.3 g. of niter cake, showing, on analysis, 35 per cent acidity measured as sulphuric acid, and 22.3 g. of sodium nitrite is then added so as to diazotize the aniline sulphate,

which then becomes coupled with the excess of aniline to produce diazoamidobenzene, which separates out quantitatively and immediately from the water solution. (1,320,443; assigned to E. I. du Pont de Nemours & Co.; Nov. 4, 1919.)

Barium Nitrate From Barium Sulphide.—The conversion of alkaline earth sulphides into nitrates is conveniently accomplished by double decomposition with nitrates of metals whose sulphides are not stable in water solution, being hydrolyzed with the formation of H_2S and the hydroxide of the metal used. Nitrates of aluminum, magnesium and chromium are specifically mentioned by ROBERT W. DAVIS, JR., of Jenkintown, Pa. Using aluminum nitrate, the reaction which takes place at the boiling point of the solution may be written:

$$3BaS + 2Al(NO_3)_3 + 6H_2O = 3Ba(NO_3)_2 + 2Al(OH)_3 + 3H_2S$$

The aluminum hydroxide, being insoluble and in a flocculent form, is easily filtered off, so that a pure solution of barium nitrate is obtained. (1,321,013; Nov. 4, 1919.)

Precipitating Anthranilic Acid From Aqueous Solutions.—The sodium salt of anthranilic acid is ordinarily made by treating phthalimide with sodium hypochlorite and sodium hydroxide in accordance with the equation:

$$C_6H_4\begin{matrix}CO\\CO\end{matrix}NH + NaOCl + 3NaOH =$$

$$C_6H_4\begin{matrix}COONa\\NH_2\end{matrix} + Na_2CO_3 + NaCl + H_2O$$

In attempting to precipitate anthranilic acid from the solution by means of HCl or H_2SO_4, difficulty is experienced in determining the correct amount of acid to use, since an insufficient amount will fail to precipitate all of the anthranilic acid, while an excess will result in the formation of the water-soluble hydro chloride (or sulphate) of anthranilic acid. During the process of acidification, the sodium carbonate is converted into chloride or sulphate. These sources of loss are remedied by RALPH S. POTTER, of Grantwood, N. J., in the following manner. The solution is first treated with CO_2, whereby at least 50 per cent of the sodium present as Na_2CO_3 is recovered as bicarbonate. The anthranilic acid is now precipitated by an acid which is too weak to form a salt with it, such as H_2SO_4, so then an excess has no harmful effect on the yield. (1,322,052; assigned to The Barrett Co.; Nov. 18, 1919.)

Treating Black Liquor From Sulphate Pulp.—The alkali losses incurred in the treatment of black liquor and in the preceding pulp-manufacturing process are usually compensated by the addition of salt cake to the black ash before calcination. The sulphate is reduced to sulphide during the latter operation. The carbonate which is also formed must be causticized by treatment with lime before it can be used in the digester. ELIS OLSSON, of East Angus, Que., proposes the substitution of niter cake for salt cake, thereby converting the carbonate into sulphate and avoiding the use of lime. The cooking liquor prepared from this product will contain sodium sulphide as the active agent. (1,322,043; Nov. 18, 1919.)

Purification of Iodine.—Certain impurities present in commercial iodine, such as iron iodide, iodine chloride and iodine bromide, cannot be removed by the process of sublimation. RAY M. CARTER, of Baltimore, Md., has patented the following method of purification: 200 lb. commercial iodine and a solution of 10 lb. KI in 100 lb. water are placed in a kettle, and steam is introduced through a perforated coil in the bottom. The steam decomposes the impurities referred to, liberating the iodine. The iodine vapors (mixed with steam) are condensed and the wet iodine dried at room temperature under a vacuum of 28 in. of mercury. (1,324,761; assigned to U. S. Industrial Alcohol Co.; Dec. 9, 1919.)

Anthraquinone and Phthalic Anhydride by Catalytic Oxidation.—CHESTER E. ANDREWS, of Pittsburgh, Pa., has found that aromatic hydrocarbons containing side chains or more than one ring may be oxidized by boiling with sulphuric acid in the presence of oxides of molybdenum or vanadium. Oxidizing agents such as sodium dichromate or manganese dioxide may be used, and the catalytic effect of the molybdenum or vanadium oxide is increased in many instances by the admixture of compounds or oxides of metals of the fifth or sixth group of the periodic system. Anthracene and ortho-xylene when treated in this manner, using 50 per cent H_2SO_4, yield anthraquinone and phthalic anhydride respectively. (1,324,715; assigned to the Selden Co.; Dec. 9, 1919.)

Personal

ROY N. BUELL will leave Battle Creek, Mich., the end of February to build a powdered lignite fuel plant in Melbourne, Australia.

G. M. BUTLER, director of the Arizona Bureau of Mines and dean of the College of Mines and Engineering, has been elected to head the Chamber of Commerce, Tucson, Ariz., for the coming year.

E. W. ENGELMANN has been appointed to the position of consulting research engineer for the Utah Copper, Chino Copper, Ray Consolidated Copper and Nevada Consolidated Copper companies, with headquarters in Salt Lake City.

ARTHUR G. HENRY, metallurgist for the Illinois Tool Works and secretary of the American Steel Treaters' Society, has resigned to become Chicago representative of the Vanadium Alloys Steel Co.

Dr. E. H. LESLIE has resigned from his position as assistant to the president and to the general manager of the U. S. Industrial Alcohol Co. of New York City and has accepted a position as associate professor of chemical engineering at the University of Michigan, Ann Arbor, Mich.

ALEXANDER MACKAY, president of the Dundee-Arizona Copper Co., with his son, Captain F. B. MACKAY, both of Dundee, Scotland, have made an inspection of the property of the company at Jerome, Ariz.

Dr. E. S. MERRIAM has resigned the professorship of chemistry of Marietta College to accept the position of chief chemist for the Safe-Cabinet Co., Marietta, Ohio.

R. B. MOORE, chief chemist, U. S. Bureau of Mines, was in Golden, Col., during the latter part of January in connection with the co-operative work on oil investigations undertaken by the State of Colorado and the Bureau of Mines.

R. A. ROSS, a member of the Administrative Commission of the City of Montreal, has been elected president of the Engineering Institute of Canada.

E. E. THUM, associate editor of CHEMICAL & METALLURGICAL ENGINEERING, spoke Wednesday evening, Feb. 18, on "The Effect of Phosphorus and Sulphur in Steel" under the auspices of the American Steel Treaters' Society at the Bush Terminal Bldg., New York.

HENRY E. WOOD, formerly of Denver, Col., who has been living in New York for the past year or two, has gone to Freeport, La., for a few months.

Obituary

Dr. DAVID S. PRATT, formerly assistant director of the Mellon Institute of Industrial Research of the University of Pittsburgh, died in St. Louis, Mo., on Jan. 28, after a short illness from pneumonia. He was a member of the American Chemical Society and of the following fraternities: Phi Kappa Sigma, Sigma Xi, Alpha Chi Sigma, and Phi Lambda Upsilon.

David Shepard Pratt was born in Towanda, Pa., on Sept. 20, 1885, the son of Charles Manville and Louise Hale (Woodford) Pratt. Following the completion of the collegiate course at Cornell University (A.B., 1908), he was appointed a Fellow in Chemistry at that institution (1909-1911) and in 1911 he received the degree of Ph.D. Dr. Pratt then joined the staff of the Bureau of Chemistry, Washington, D. C., as assistant chemist, but shortly afterward was selected as chief of the Organic Division of the Bureau of Science in Manila, P. I., where he spent three productive years in chemical research and as a member of the Pure Food and Drug Board. In 1914 he decided to return to the States and accepted a professorship of chemistry at the University of Pittsburgh. Dr. Pratt occupied that chair and the headship of the organic department of the School of Chemistry at "Pitt" from 1914 to 1917, in which year he was made an assistant director of the Mellon Institute of Industrial Research. On Jan. 1, 1920, Dr. Pratt resigned at the Institute and was arranging to enter consulting chemical practice in St. Louis, Mo., at the time of his fatal illness.

Dr. Pratt was known principally for his published investigations on phthalic acid derivatives, but his reports of researches on various problems in the domain of tropical chemistry have also been of importance and he was a recognized authority on chemical Philippiniana. At the Mellon Institute Dr. Pratt enjoyed broad opportunities to apply, in the inquiries of the Industrial Fellowships under his supervision, his splendid equipment in chemistry and many results of technical importance were obtained through his suggestive aid. His profound knowledge of pure organic chemistry and his familiarity with research methods were respected by his associates and played a prominent part in establishing the high success of the system in operation at the Institute. His departure to enter professional practice was sincerely regretted by all of the members of the institution. Dr. Pratt resided in St. Louis at 38 Portland Pl. He is survived by his wife, Fredonia Elizabeth (Johnson) Pratt, and an infant son, David Shepard Pratt, Jr.

Current Market Reports

The Non-Ferrous Metal Market

New York, Feb. 20, 1920.—The copper market continues dull. Lead, zinc and tin have strengthened.

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots	11.25
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	60.00
Lead, New York, spot	9.00
Lead, E. St. Louis, spot	8.37½
Zinc, spot, New York	9.50
Zinc, spot, E. St. Louis	9.22½
Silver (Dollars per oz.)	1.32¼

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	27.50
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	33.50
Seamless bronze tubing	34.50
Seamless brass tubing	30.50

RARER METALS

Cadmium	lb.	$1.50
Cobalt	lb.	1.50
Platinum	oz.	150.00
Iridium	oz.	250.00
Palladium	oz.	150.00
Mercury	75 lb.	85.00

SCRAP METALS

	Cents per Lb.
Aluminum, cast scrap	23½@24½
Aluminum, sheet scrap	22½@23½
Aluminum clippings	25½@27
Copper, heavy machinery comp	14½@14½
Copper, heavy and wire	13½@14
Copper, light and bottoms	12½@12½
Copper, heavy cut and crucible	15½@16
Brass, heavy	7½@8½
Brass, casting	10½@10½
Brass, light	5½@6½
No. 1 clean brass turnings	8½@8½
No. 1 comp. turnings	12 @12½
Lead, tea	5½@5½
Lead, heavy	6½@7
Zinc, scrap	4½@4½

Chemical and Allied Industrial Markets

New York, February 20, 1920.

Advancing prices among the heavy chemicals due to a low supply in some lines is the report of the week. Delivery on contracts has been held up by the recent storm, which, added to the car shortage, has caused considerable anxiety among the trade. Exporting has fallen off slightly owing to the abnormal rate of exchange and the great difficulty of obtaining shipments.

GENERAL CHEMICALS

Barium chloride has been active, with very little material to be found on the spot market. Quotations as high as $140@$150 per ton are reported, but the average price varied from $90@$110 per ton. A sudden stop in supplies has caused a jump in *bichromate of soda* to 33c. per lb. Producers ran short of coal, which, combined with the crippling of transportation, left the market empty. The price quoted on this item last week was from 21@23c. per lb. Exporting of *caustic soda* has been affected by the rate of exchange, and until this situation is relieved conditions will remain unsettled. Sales have been reported at $4.60 per cwt., while the prevailing price seems to be around $4.50 per cwt. *Soda ash* has also felt the drop in the money market, but producers are so completely sold out that this will hardly lessen the pressure. The average quotation on domestic light is about $2.25 per cwt., while $2.35 is the listing for foreign. *Formaldehyde* is practically unobtainable. The quotation of 52@55c. per lb. is the average for what small lots are changing hands. The increasing shortage on *bleaching powder* has advanced the price to $3.50 per cwt., while $4@$4.50 is being asked for small quantities on spot. The scarcity in the *ammonia* products has held this branch of the market firm, with very few shipments reported during the week.

COAL-TAR PRODUCTS

This market remains practically unchanged. Large producers are withdrawing a number of items from their list of products due to the inability to meet the demand. Lack of raw materials and disadvantage of small plant facilities are accountable for this situation. Many firms are completely sold out and are having difficulty meeting contracts. The recent transportation tie-up has also affected this industry seriously. *Dimethylaniline* is the center of this group. Small quantities are to be had, but the report from producers is that they are all sold out. The average quotation is around $1 per lb., while $1.20 has been reported on some sales. *Phthalic anhydride* remains quiet at quotations varying from 50@80c. per lb. One large producer who has been out of the market for some time past is working on a process to produce a better grade than average market material at a cheaper price.

NAVAL STORES

Another drop in all grades of *rosin* has been caused by the falling off of export inquiry. The rate of exchange is directly accountable for this situation, and it is the opinion of many that the market will continue dull until more

favorable conditions arise. *Spirits of turpentine* is easier at $1.93@$1.95 per gal., with plenty of material on the domestic market.

Crude Rubber

The steady drop in this market has tempted buyers to invest for more than their present needs and as it seems they are waiting for more stable conditions. This field is probably feeling the drop in sterling more than any other market. *Para, up-river fine*, is quoted at 44c. per lb., while *caucho ball* is listed at 33½c. per lb. *First latex crepe* dropped to 48c. and *amber crepe* No. 1 is going at 45c. per lb.

The Iron and Steel Market

Pittsburgh, Pa., February 19, 1920.

Indications have increased that if the steel industry is able to operate at a fairly full rate and is able to ship its products there will be no acute scarcity of steel. There has been much opinion expressed in the past few weeks contrary to this view. Some of it has been expressed chiefly for the purpose of furnishing an argument for advancing selling prices of steel products. Buyers of steel have been equally responsible for views that there would not be enough steel to meet all requirements, since they have been free in the bidding of premium prices for early deliveries.

It is a very favorable circumstance that despite car shortages, affecting steel production in various ways, and despite predictions that there would be a short supply of labor for several months, with inefficiency, the production of steel has increased steadily, until it is now at a rate of nearly 90 per cent of capacity.

Coke Production Increasing

There has been no material change in the car supply in the Connellsville coke region for several weeks, the production having been practically uniform since the week ended Dec. 27, which was one of light production, on account of the holiday. Coke production at byproduct ovens, on the other hand, has increased rather steadily, as better coal supplies have been received, and this week further improvement is reported in this respect. Byproduct coke production is not yet up to normal at all points, but it is at a much better rate than one month or two months ago, and several individual plants are reported as being in full operation, with all ovens on and at normal coking time.

Shipping Finished Product

At nearly all steel mills car supplies for shipping finished product have proved more or less inadequate. Traffic managers have been very busy endeavoring to secure additional cars, and have had considerable success, though such success is never permanent, involving merely an additional supply of cars for a time, not a permanent increase in the trade. The quantity of finished steel lying at mills and awaiting shipment is very large, but has hardly increased in the aggregate in the past week or two. There has been little if any actual curtailment in steel production owing to finished material backing up against the rolls, a development that was feared and one that is not for a certainty forestalled even now. By as much as the supply of steel in the hands of jobbers and manufacturing consumers has been curtailed by the failure of steel produced to move to destination, by so much will there be extra supplies when the steel eventually is shipped.

Higher Steel Prices

The United States Steel Corporation continues to adhere to the March 21 or Industrial Board prices, and accordingly its entire product is taken up by regular customers so that there is no material left to offer to the customers of other mills, or to chance buyers. Among the independents, two large interests have committed themselves to the policy of taking care of regular customers at prices, except in the case of wire products, approximately equal to those ruling before the March 21 reductions, but one at least of these independents is quite ready to charge casual buyers, not regular customers, much higher prices when the buyer is willing to pay such prices, for early delivery. Among other mills various policies are pursued, the more common one being to stay almost entirely out of the market. Thus, while it is very hard to buy steel, there is also a condition of many of the mills not being sold far ahead by any means.

No Definite Price List

There is no definite list of prices now representing the steel market, as forward deliveries are unusual, and prompt deliveries vary in price according to time of delivery and tonnage. Prices on the whole are higher than a week or two ago, and the market in general seems to be in process of a runaway. Plates for anything like early delivery are now 3.75@4c. Bars are 3.50@4c. Dealers in oil well supplies have bid 3.50c. freely for "augur stems," representing a particularly economical form of steel bar to roll.

Sheets are selling at a very wide range of prices. While a chance buyer could not secure any black sheets at 4.50c., there has been some business done by mills with regular customers at this figure, $3 a ton above the March 21 price. More tonnage is moving at 4.65c. and still more at 5c., while small lots are bringing 6c., 6.50c. and 7c. In all cases the lower priced sales are to regular customers of the mills, while the highest priced transactions are with jobbers or speculators who have an opportunity to turn the material over at a profit. Blue annealed sheets have sold at 4.50c. in a moderate way, the March 21 price being 3.55c., while sales of some volume have been made at 5c. and even at 5.50c. Galvanized sheets are selling similarly at 6@8c., the March 21 price being 5.70c.

Wire nails for early delivery and regular mill lots are fairly well established at $4.25 per keg, base. The March 21 price, still adhered to by the American Steel & Wire Co., was $3.25, while the war control price was $3.50.

Pig Iron

The pig iron markets have continued to move upward, there being urgent buying pressure on the part of a few consumers, while producers have been very reserved about selling. In the past few weeks there has been practically nothing but second half iron to sell, and as furnaces regarded sales for that delivery as "backlog business" they have been indisposed to sell more than, say, one-third of their product at the opening prices. In the past two or three days there have been some signs of there being less buying pressure, and in some quarters, even among producers, predictions are now being made that present prices will be found to represent the top level on this movement. Seeing that they are far above the war-time prices and are more than two and one-half times the 10-yr. pre-war average of pig-iron prices, predictions that the advance has stopped cannot be regarded as wholly unreasonable. It is a fact well attested in history that all price advances have stopped at one time or another.

The valley market now stands at $42 for bessemer, $43 for basic and $42 for foundry. Basic had trailed far behind foundry, but took a sudden spurt last week. The Philadelphia market stands at $46.35, delivered, for No. 2X, Buffalo being $44.25 for No. 2X. Cleveland is about $42 for foundry iron, and Chicago $43. The Birmingham market remains at $40, with offerings rather light at the figure.

Ferro-Alloys

Domestic makers of ferromanganese seem to be well sold up for the half year, while for the second half they are selling only in a limited way at their recently advanced price of $160, delivered, for 76 to 80 per cent alloy. English is quoted at $150 c.i.f. Spiegeleisen is quoted at $56 to $57, furnace, for 19 to 21 per cent.

Electrolytic ferrosilicon is quiet at $80 for 50 per cent and $140 for 75 per cent, delivered Pittsburgh, valleys and Cleveland. Bessemer ferrosilicon is quoted at $59.50 for 10 per cent, $62.80 for 11 per cent and $66.10 for 12 per cent f.o.b. Jackson, Ohio.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.60 – $0.65
Acetone	lb.	$0 16 –$0 20	.21 –
Acid, acetic, 28 per cent	cwt.	2 75 – 3 00	3.00 – 3.25
Acetic, 56 per cent	cwt.	5 25 – 5 75	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 –12.50	13.50 – 15.50
Boric, crystals	lb.	.14½– .15½	.15½– .16½
Boric, powder	lb.	.14½– .15	.15 – .16
Hydrochloric	lb.	.08 –	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.14 –
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.05 – .06	.05½– .07
Molybdic, C. P.	lb.	–	4.25 – 5.00
Nitric, 40 deg.	lb.	.06 – .07	.07½– .08½
Nitric, 42 deg.	lb.	.06½– .07	.08 – .09½
Oxalic, crystals	lb.	.35 – .40	.40 – .45
Phosphoric, Ortho, 50 per cent solution	lb.	.24 –	–
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2 50 – 2 55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	17.50 –22.00	–
Sulphuric, 60 deg., drums	ton	–	–
Sulphuric, 66 deg., tank cars	ton	22.00 –25.00	–
Sulphuric, 66 deg., drums	ton	–	–
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 –30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	32.00 –	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	35.00 –	40.00 –
Tannic, U. S. P.	lb.	–	1.35 – 1.45
Tannic (tech.)	lb.	–	.42 – .55
Tartaric, crystals	lb.	–	.69 – .74
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
*Alcohol, Ethyl	gal.	4.80 – 5.50	6.00 – 7.00
*Alcohol, Methyl	gal.	1.50 –	1.52 – 1.57
*Alcohol, denatured, 188 proof	gal.	–	.65 – .78
*Alcohol, denatured, 190 proof	gal.	–	.67 – .74
Alum, ammonia lump	lb.	.04½– .05	.05½– .06
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½– .02	.02½– .02½
Aluminum sulphate, iron free	lb.	.02½– .03	.03½– .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08¼– .10¼	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.35 – .37
Ammonium carbonate, powder	lb.	.13 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac)	lb.	.14 – .15	.16 – .17½
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.10 – .12	–
Ammonium sulphate	lb.	.05 –	.06 –
Amylacetate	gal.	–	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	–	.10½– .11
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	–
Barium chloride	ton	85.00 –95.00	100.00 –110.00
Barium dioxide (peroxide)	lb.	.26 – .27	.28 – .30
Barium nitrate	lb.	.11 – .12	.13 – .14
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.03¾– .04
Bleaching powder (see calcium hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.90 – .95	–
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	–	.04½ .05
Calcium chloride, fused, lump	ton	20.00 –25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½– .01½	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	– 3.50	4.00 – 4.50
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 – .80
Calcium sulphate, pure	lb.	–	.25 – .30
Carbon bisulphide	lb.	.06 – .08	.09 – .10
Carbon tetrachloride, drums	lb.	.10½– .11	.12 – .15½
Carbonyl chloride (phosgene)	lb.	–	.75 – 1.00
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.08 –
Chloroform	lb.	.28 – .29	.30 – .31
Cobalt oxide	lb.	–	1.50 – 1.55
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08¼– .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	3.00 – 3.25
Formaldehyde, 40 per cent	lb.	–	.45 – .55
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.24½– .26
Iodine, resublimed	lb.	–	4.10 – 4.30
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate (copperas)	cwt.	1.20 –	1.25 – 1.75
Lead acetate, normal	lb.	.12 – .13	.14 – .23
Lead arsenate (paste)	lb.	–	.13 – .17
Lead nitrate, crystals	lb.	–	.70 – .80
Litharge	lb.	–	.09½– .10½
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	–	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	2.15 – 2.63	2.75 – 3.00
Magnesium sulphate, commercial	100 lb.	1.75 –	2.00 – 2.50
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.12½– .13	.17 –
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	–	.60 – .65
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.32 – .33	.34 – .37
Potassium bitartrate (cream of Tartar)	lb.	–	.56 – .60
Potassium bromide, granular	lb.	–	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.26 – .27	.28 – .30
Potassium chlorate, crystals	lb.	.16 – .20	.21 –
Potassium hydroxide (caustic potash)	lb.	.28 – .32	.35 – .42
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	$0.65 – $0.95

*Nominal quotations.

		Carlots	Less Carlots
Potassium prussiate, red	lb.	1.00 – 1.05	1.10 – 1.20
Potassium prussiate, yellow	lb.	–	.40 – .70
Potassium sulphate	ton	$225.00 –	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake (sodium sulphate)	ton	18.00 –21.00	–
Silver cyanide	oz.	–	1.25 –
Silver nitrate	oz.	–	.81½– .82½
Soda ash, light	100 lb.	2.15 – 2.25	2.30
Soda ash, dense	100 lb.	2.25 – 2.50	2.50 – 2.75
Sodium acetate	lb.	.06½– .07	.07 – .08
Sodium bicarbonate	100 lb.	2.40 –	2.75 – 3.00
Sodium bichromate	lb.	.33 – .34	.35 – .36
Sodium bisulphate (nitre cake)	cwt.	6.00 – 7.00	8.00 – 10.00
Sodium bisulphite	ton	7.00 – 8.00	8.50 – 9.00
Sodium borate (borax)	lb.	.08½– .08¾	– .09
Sodium carbonate (sal soda)	100 lb.	1.40 – 1.55	1.50 – 1.75
Sodium chlorate	lb.	.10 –	.12 – .14
Sodium cyanide, 96-98 per cent	lb.	.30 –	.31 – .34
Sodium fluoride	lb.	.14 –	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	–	4.35 – 4.60
Sodium hyposulphite	lb.	–	.03¾ .04
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.15 – .17	– .18
Sodium peroxide, powdered	lb.	–	.30 – .32
Sodium phosphate, dibasic	lb.	.03½– .04½	.04½– .05
Sodium potassium tartrate (Rochelle salts)	lb.	.40 – .42	.43 – .45½
Sodium prussiate, yellow	lb.	.23 – .29	.30 – .40
Sodium silicate, solution (40 deg.)	lb.	.01½– .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½– .03	.05 – .06
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.15 – 1.50	1.60 – 2.00
Sodium sulphide, crystal, 60–62 per cent (conc)	lb.	–	.05 – .06
Sodium sulphite, crystals	lb.	.03½–	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 –
Sulphur chloride	lb.	.05½–	.06 –
Sulphur, crude	ton	22.00 –	–
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½–	.46 – .50
Tin oxide	lb.	.50 – .60	.65 –
Zinc carbonate, precipitate	lb.	–	.20 –
Zinc chloride, gran.	lb.	.13 –	.13½– .15
Zinc cyanide	lb.	.49 –	.50 –
Zinc dust	lb.	.11½– .12½	.13 – .15
Zinc oxide, dry American	lb.	–	.09½– .12
Zinc sulphate	lb.	.03½– .03¾	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 —	$1.10
Alpha naphthol, refined	lb.	1.40 —	1.60
Alpha naphthylamine	lb.	.34 —	.42
Aniline oil, drums extra	lb.	.34 —	.45
Aniline salts	lb.	.42 —	.50
Anthracine, 80% in drums (100 lb.)	lb.	.75 —	1.00
Benzaldehyde (f.f.c.)	lb.	2.00 —	2.10
Benzidine, base	lb.	1.05 —	1.25
Benzidine, sulphate	lb.	.90 —	1.00
Benzoic acid, U.S.P.	lb.	.90 —	1.10
Benzoate of soda, U.S.P.	lb.	.80 —	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 —	.36
Benzol, 90%, in drums (100 lb.)	gal.	.25 —	.29
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech	lb.	.25 —	.35
Beta naphthol benzoate	lb.	.50 —	.55
Beta naphthol, sublimed	lb.	.65 —	.80
Beta naphthol, tech	lb.	.45 —	.55
Beta naphthylamine, sublimed	lb.	2.25 —	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 —	.18
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85 —	1.10
Cresylic acid, 95-97%, dark, in drums	gal.	.80 —	1.00
Cresylic acid, 50%, first quality, drums	gal.	.70 —	–
Dichlorbenzol	lb.	.07 —	.10
Diethylaniline	lb.	1.40 —	1.50
Dimethylaniline	lb.	.95 —	1.20
Dinitrobenzol	lb.	.26 —	.37
Dinitroclorbenzol	lb.	.25 —	.30
Dinitronaphthaline	lb.	.45 —	.55
Dinitrophenol	lb.	.32 —	.36
Dinitrotoluol	lb.	.38 —	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 —	.40
Diphenylamine	lb.	.55 —	.65
H-acid	lb.	1.60 —	1.75
Metaphenylenediamine	lb.	1.15 —	1.80
Monochlorbenzol	lb.	.12 —	.15
Monoethylaniline	lb.	1.50 —	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06 —	.08
Naphthaline, flake	lb.	.07 —	.08
Naphthaline, balls	lb.	.08½ —	.10
Naphthionic acid, crude	lb.	.75 —	1.25
Nitrobenzol	lb.	.14 —	.19
Nitro-naphthaline	lb.	.30 —	.35
Nitro-toluol	lb.	.20 —	.30
Ortho-amidophenol	lb.	3.75 —	4.25
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.80 —	1.25
Ortho-nitro-toluol	lb.	.25 —	.40
Ortho-toluidine	lb.	.25 —	.45
Para-amidophenol, base	lb.	2.50 —	3.50
Para-amidophenol, HCl	lb.	2.50 —	3.25
Para-dichlor-benzol	lb.	.12 —	.18
Paranitraniline	lb.	1.00 —	1.35
Para-nitro-toluol	lb.	1.35 —	1.50
Paraphenylenediamine	lb.	2.15 —	3.00
Paratoluidine	lb.	1.75 —	2.50
Phthalic anhydride	lb.	.60 —	.80
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 —	.25
Pyridin	gal.	2.00 —	2.50
Resorcin, technical	lb.	3.75 —	4.50
Resorcin, pure	lb.	6.50 —	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.43 —	.45
Salicylic acid, U. S. P.	lb.	.55 —	.60
Salol	lb.	.90 —	.95

Solvent naphtha, water-white, in drums, 100 gal.	gal.	$0.22	—	$0.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42	—	$0.45
Beeswax, refined, yellow	lb.	.47	—	.48
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1	lb.	.80	—	.88
Carnauba, No. 2, regular	lb.	.65	—	.78
Carnauba, No. 3, North Country	lb.	.46	—	.48
Japan	lb.	.18½	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.....	—	.07½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.....	—	.07½
Paraffine waxes, refined, 118-120 m.p.	lb.	.....	—	.10½
Paraffine waxes, refined, 128-130 m.p.	lb.	.09½	—	.10½
Paraffine waxes, refined, 133-135 m.p.	lb.	.....	—	.13
Paraffine waxes, refined, 135-137 m.p.	lb.	.....	—	.14
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.45
Pine oil, pure, dest. dist.	gal.	.....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.40
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.48
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.70
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.60
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17.45	—	$18.50
Rosin E-I	280 lb.	17.50	—	18.75
Rosin K-N	280 lb.	18.50	—	21.50
Rosin W. G.-W. W.	280 lb.	20.75	—	24.25
Wood rosin, bbl.	280 lb.	16.25	—	17.50
Spirits of turpentine	gal.	.....	—	1.94
Wood turpentine, steam dist.	gal.	.....	—	1.93
Wood turpentine, dest. dist.	gal.	.....	—	1.85
Pine tar pitch, bbl.	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	14.75
Retort tar, bbl.	500 lb.	15.00	—	15.25
Rosin oil, first run	gal.	.93	—	.95
Rosin oil, second run	gal.	.95	—	.97
Rosin oil, third run	gal.	1.10	—	1.15
Rosin oil, fourth run	gal.	.....	—	1.18

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$3.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.44	—	$0.46
Upriver coarse	lb.	.33	—	.35
Upriver caucho ball	lb.	.33½	—	.34½
Plantation—First latex crepe	lb.	.48	—	.49
Ribbed smoked sheets	lb.	.47	—	.48
Brown crepe, thin, clean	lb.	.42	—	.43
Amber crepe No. 1	lb.	.45	—	.....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18	—	$0.19
Castor oil, AA, in bbls.	lb.	.21	—	.23
China wood oil, in bbls.	lb.	.24½	—	.25½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18½	—	.19½
Cocoanut oil, Cochin grade, in bbls.	lb.	.20½	—	.23
Corn oil, crude, in bbls.	lb.	.19	—	.22
Cottonseed oil, crude (f.o.b. mill)	lb.	.19	—	.20
Cottonseed oil, summer yellow	lb.	.22	—	.27
Cottonseed oil, winter yellow	lb.	.24½	—	.25½
Linseed oil, raw, car lots	gal.	1.77	—	1.87
Linseed oil, raw, tank cars	gal.	1.70	—	1.80
Linseed oil, boiled, car lots	gal.	1.75	—	1.80
Olive oil, commercial	gal.	3.00	—	3.10
Palm, Lagos	lb.	.16½	—	.16½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	—	.24
Peanut oil, refined, in bbls.	lb.	.27	—	.28
Rapeseed oil, refined in bbls.	gal.	1.45	—	1.68
Rapeseed oil, blown, in bbls.	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.19	—	.23
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.17½	—	.20

FISH

Winter pressed Menhaden	gal.	$1.20	—	.....
Yellow bleached Menhaden	gal.	1.23	—	.....
White bleached Menhaden	gal.	1.25	—	.....
Blown Menhaden	gal.	1.26	—	.....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.04	—	.05
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb.	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	13.50	—	18.00
Fluor spar, acid grade, lump, f.o.b. mines	net ton	30.00	—	45.00
Fluor spar, acid grade, ground, f.o.b. mines	net ton	50.00	—	52.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Graphite, crucible, 85% carbon content	lb.	.....	—	.07½
Graphite, crucible, 86% carbon content	lb.	.....	—	.07½
Graphite, crucible, 87% carbon content	lb.	.....	—	.07½
Graphite, crucible, 88% carbon content	lb.	.....	—	.08
Graphite, crucible, 89% carbon content	lb.	.....	—	.08½
Graphite, crucible, 90% carbon content	lb.	.....	—	.08½
Graphite, crucible, 91% carbon content	lb.	.....	—	.08½
Graphite, crucible, 92% carbon content	lb.	.....	—	.09
Graphite, crucible, plus 92%	lb.	.....	—	.12
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, orange, fine	lb.	.....	—	.....
Shellac, orange, superfine	lb.	1.70	—	1.75
Shellac, A. C. garnet	lb.	nominal		
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	38-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	33-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	45-50 at Mt. Union, Penn

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	—	.50
Ferro-manganese, 70-80% Mn	gross ton	155.00	—	165.00
Spiegeleisen, 16-20% Mn	gross ton	50.00	—	60.00
Ferro-molybdenum, per lb. of Mo	lb.	3.00	—	3.50
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr_2O_3	unit	$0.60	—	$0.85
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	7.50
*Coke, furnace, o.b. ovens	net ton	6.00	—	6.50
Petroleum coke, refinery, Atlantic seaboard	net ton	.....	—	14.00
Fluor spar, gravel, f.o.b. mines	net ton	.....	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

*Government prices.

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ½-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ½-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.85
Sheets, No. 10 blue annealed	100 lb.	4.00
Sheets, No. 28 galvanized	100 lb.	6.20

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

California

LOS ANGELES—The Los Angeles Soap Co., 633 East 1st St., has awarded the contract for the construction of a 1-story, 45x125-ft. factory at 1st and Banning Sts., to the Davidson Constr. Co., 1445 East 16th St., at $23,800.

Idaho

MALAD—The Town Council will soon award the contract for furnishing labor and material for the construction of 2,800 ft. 18-in. vitrified tile and 2,300 ft. open canal sewer in Dist. 1. A 30x50-ft. septic tank will be included in the project. J. H. Giles, engr.

Illinois

CHICAGO—The Acme Steel Goods Co., 2834 Archer Ave., has awarded the contract for the construction of a 1-story, 150x600-ft. building to house twenty 10-in. cold roll mills and corresponding ovens, etc., adjoining its present plant at Riverdale, to R. F. Wilson & Co., 1851 Elston Ave.

CHICAGO—The Concrete Steel Co., 53 West Jackson St., has awarded the contract for the construction of a 1-story, 80x100-ft. factory at Central Park Ave. and 31st St., to James Shedden & Co., 106 North La Salle St. Estimated cost, $25,000.

MOLINE—Williams, White & Co., 3rd Ave. and 8th St., plans to build a 1-story, 110x325-ft. foundry on 43rd St., between 3rd and 4th Aves. C. A. Hardy Co., Ry. Exch. Bldg., Chicago, engr.

Indiana

HAMMOND—The La Salle Steel Co., 2243 South Halsted St., has purchased a site on the North Side and plans to build a steel fabricating plant, consisting of 3 buildings, on same. Estimated cost, $1,000,000.

INDIANAPOLIS—The Acme Aluminum & Brass Wks., 420 South Harding St., is having plans prepared for the construction of factory. Estimated cost, $70,000.

INDIANAPOLIS — The Van Briggle Chemical Co., 16th St. and Capital Ave., will receive bids about March 1 for the construction of a chemical manufacturing plant. Estimated cost, $125,000. Charles E. Bacon, 1110 Odd Fellows' Bldg., archt.

Iowa

STANTON—The city will receive bids until March 4 for the construction of sewers and a disposal plant. Estimated cost, $60,000. Theodore S. DeLay, Creston, engr.

Louisiana

NEW ORLEANS—The Go-Ro Co., 826 Barrone St., plans to build a factory and is in the market for a Joet Ram squeeze molding machine, milling machines, screw milling and Fox monitor, cupola, tumbling mills, sand blast machine, core oven, etc. Estimated cost, $150,000.

Michigan

GRAND RAPIDS—The Toledo Plate & Window Glass Co., 19 Ottawa Ave., has awarded the contract for the construction of a 2-story, 123x130-ft. factory, including warehouse and office building, to C. Hoertz & Sons, 659 Bridge St. Estimated cost, $95,000.

NORTHVILLE—C. Freiburger, secy., Bd. of Health, 233 St. Antoine St., Detroit, will receive bids until March 1 for the construction of a 2-story, 28x36-ft. laboratory, in connection with the group of buildings to be constructed at the proposed Detroit Municipal Tuberculosis Sanitarium. Laboratory equipment will be installed in same. Stratton & Snyder, 1103 Union Trust Bldg., Detroit, archts.

Missouri

KANSAS CITY—The Cleveland Steel Barrel Co., 9612 Meech Ave., Cleveland, plans to build an 80x290-ft. factory at Southwest Blvd. and Hill St. This will be the first unit of a Western plant.

New Jersey

TRENTON—The Joseph Stokes Rubber Co., Taylor St., has awarded the contract for the construction of a 2-story, 70x100-ft. rubber factory, to N. A. K. Bugbee Co., 206 East Hanover St. Estimated cost, $35,000.

TRENTON—The Mercer Motor Co., Whitehead Rd., has awarded the contract for the construction of a 2-story, 40x73-ft. office building and a 1-story, 80x400-ft. paint shop, to the Standard Constr. Co., 1713 Sansom St., Philadelphia. Estimated cost, $200,000. Noted Jan. 28.

New York

BATAVIA—The city has revised plans prepared by A. Clark, city engr., for the installation of a gravity sewage disposal system to replace present pumping system. Estimated cost, $200,000.

ELMIRA—The General Electric Co., Hulett Bldg., has awarded the contract for the construction of a 1-story, 110x560-ft. foundry, to H. K. Ferguson Co., 6532 Euclid Ave., Cleveland. Estimated cost, $300,000.

NIAGARA FALLS—The Kimberly & Clark Co., Neenah, Wis., will receive bids for the construction of a paper mill on Royal Ave. Estimated cost between $175,000 and $200,000.

ROCHESTER—The New York Sewer Pipe Co., 545 Oak St., plans to rebuild the 5-story building which was recently destroyed by fire, entailing a loss from $40,000 to $50,000.

ROCHESTER—Sargent & Greenleaf Co., Court St., manufacturer of locks, plans to construct a 1-story, 185x214-ft. factory, 2-story, 40x214-ft. office building and a 1-story, 40x128-ft. brass foundry and power house on Norton St. The company is in the market for foundry equipment.

SYRACUSE—The Oberdorfer Brass Co., Water St., plans to build a 1-story, 280x440-ft. auto castings factory at Messina Springs. Estimated cost, $350,000. M. L. King, Snow Bldg., engr.

TUCKAHOE—The Hodsman Rubber Co. will soon award the contract for the construction of a 5-story, 60x150-ft. factory addition. Estimated cost, $200,000. W. L. Stoddart, 9 East 40th St., New York City, archt. and engr.

North Dakota

COOPERSTOWN—The city plans to construct a complete sewerage system, including a disposal plant, etc. Cost to exceed $25,000. Dakota Eng. & Constr. Co., Valley City, engr.

MAYVILLE—The city voted $10,000 bonds for the installation of a water-softening plant. T. R. Atkinson, Bismarck, engr.

Ohio

CLEVELAND—The Amer. Stove Co., 4700 Perkins Ave., has awarded the contract for the construction of a 2-story, 233x265-ft. enameling plant at 4100 Hough Ave., to the Boldt Constr. Co., 6110 Euclid Ave. Estimated cost, $150,000.

CLEVELAND—The Buckeye Brass Co., 6410 Hawthorne Ave., will receive bids until March 1 for the construction of a 1-story, 30x110-ft. foundry and a 75x75-ft. furnace room on Ashland Rd. Estimated cost, $60,000. N. W. Carl, secy. Allen Sogg, 319 Hippodrome Bldg., archt.

CLEVELAND—The Ohio Fibre Container Co., 209 Williamson Bldg., plans to build 2-story factory additions at East 103rd St. and Harvard Ave. Estimated cost, $75,000. D. Jones, secy.

CLEVELAND—The Otis Steel Co., Leader-News Bldg., has awarded the contract for the construction of five steel mill buildings, to be 2-story, 75x400-ft., 1-story, 90x400-ft., 1-story, 40x400-ft., and 1-story, 80x400-ft., on Jennings Rd. to the Amer. Bridge Co., 30 Church St., New York City. Estimated cost, $500,000.

CLEVELAND—The Perfection Rubber Co., 2097 Columbus Rd., is having plans prepared for the construction of a 2-story, 100x110-ft. factory building on Brook Park Rd. Estimated cost, $60,000. L. J. Johnson, vice pres.

CLEVELAND—The United States Gypsum Co., 1714 Merwin Ave., plans to rebuild the 2-story factory which was recently destroyed by fire. Estimated cost, $100,000. P. A. Ryder, supt.

GRAFTON—The village will receive bids about April 15 for the construction of a sewerage system and a sewage disposal plant, including two sedimentation tanks. Estimated cost, $30,000. R. Winthrop Pratt, Hippodrome Bldg., Cleveland, engr.

Oklahoma

OKEMAH—The town is having plans prepared for the construction of an entire new plant, including a disposal plant. Estimated cost, $90,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, engr.

Pennsylvania

LOCK HAVEN—The Castanea Paper Co. has awarded the contract for the construction of a paper mill, including a 2-story, 425x515-ft. mill, 1-story, 60x150-ft. storehouse, and a series of clay bins, to the Turner Constr. Co., 244 Madison Ave., New York City. Estimated cost, $1,250,000.

PLAINS—The city plans to construct a sewerage system, including a sewage disposal plant. Estimated cost, $400,000.

WILKES-BARRE—The Sheldon Axle Co., 221 Conyngham Ave., plans to build a 3-story, 100x200-ft. heat treating plant on Beaumont St. Estimated cost, $200,000.

Texas

BROWNWOOD—The city plans to construct a sewerage system and a sewage disposal plant, on the South Side of the city. This plant will be another unit to the present system. Estimated cost, $50,000. E. R. Brashear, city mgr.

HOUSTON—The Lone Star Steel & Bridge Co., 214 Carter Bldg., will soon have plans prepared for the construction of a fabricating plant, having a 1,000-ton capacity per month, on Harrisburg Blvd. and the Municipal R.R. tracks. G. E. Cole, pres.

Washington

VANCOUVER — The Columbia Dairy Products Co. plans to build a 2-story, 40x80-ft. dairy plant. Pasteurizing and condensing equipment will be installed in same. Estimated cost, $45,000.

West Virginia

ELKINS—The city plans to construct a pumping station and filtration plant. Estimated cost, $130,000.

Wisconsin

KILBOURN—A. Luettgerodt, city clk., will receive bids until March 10 for the construction of a sewerage system, including a 12x15-ft. septic tank. Estimated cost, $18,000 to $20,000. Parsons & Orbert, 627 M. & M. Book Bldg., Milwaukee, engrs.

MANITOWOC—The Wisconsin Aluminum Products Co., c/o B. Dalwig, mgr., 16th and Franklin Sts., plans to build a 4-story, 60x250-ft. aluminum products factory on 8th St. Estimated cost $250,000.

MILWAUKEE—The Milwaukee Rolling Mill Co. has awarded the contract for the construction of a 1-story, 380x425-ft. steel rolling mill, to the Northwestern Bridge & Iron Co., 32nd and Hopkins Sts. Annealing ovens and oven equipment will be installed in same. Estimated cost, $400,000.

MILWAUKEE—The Pelton Steel Co., 672 Kinnickinnic Ave., has awarded the contract for the construction of a 1-story, 60x100-ft. foundry addition, to Yunker Bros., 615 37th Ave. Estimated cost, $50,000. Noted Feb. 4.

SHEBOYGAN—The Armour Leather Co., 175 North Franklin St., Chicago, has awarded the contract for the construction of a tannery, here, to Westinghouse, Church, Kerr & Co., Inc., 37 Wall St., New York City. Estimated cost, $750,000.

SOUTH WILWAUKEE (Milwaukee P. O.)—C. P. Nourse, c/o Stowell Co., is in the market for plating machinery and japaning ovens.

Ontario

BRANTFORD—The Blue Bird Co. is in the market for acetylene welding equipment, etc.

GALT—The Galt Brass Co. will construct a 58x138-ft. foundry and a 40x90-ft. extension to its vitriol plant.

KITCHENER—The Kitchener-Waterloo Collegiate Bd. is having plans prepared for the construction of a 3-story collegiate institute. Chemical and physical laboratory supplies will be installed in same. Estimated cost, $500,000. S. B. Coon & Son, 810 Excelsior Life Bldg., Toronto, archts.

OTTAWA—The Bd. of Control will receive bids in the spring for the construction of laboratories and a press building on the exhibition grounds. Estimated cost, $50,000. A. F. Macallum, City Hall, engr.

OTTAWA—The Council of the County of Carleton will receive bids in the spring for furnishing one oil distributor with heater, etc., for the Highway Dept. Patterson & Byrne, 7½ Sparks St., engrs.

Quebec

BAY DE CHALEUR—Arthur Sande, consult. engr., Lister Bldg., Hamilton, Ont., will soon award the contract for the construction of a 200-ton sulphite pulp mill, here.

LACHINE—A. Laframboise, engr., City Hall, is preparing plans for the construction of a filtration plant, etc., for the city. Estimated cost, $300,000.

THREE RIVERS—The Wayagamack Pulp & Paper Co. is building a pulp mill, here. Estimated cost, $3,000,000.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its fifth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis. Headquarters will be at the Hotel Statler.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9 and 10. Headquarters will be at the Copley-Plaza Hotel.

THE AMERICAN ELECTROCHEMICAL SOCIETY, NEW YORK SECTION, will hold a meeting on March 26, the subject of which is "Peace Uses for War Products."

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meeting in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN PETROLEUM LEAGUE will hold a meeting in Chicago, March 26 to 29.

THE CANADIAN MINING INSTITUTE will hold its annual meeting at the King Edward Hotel, Toronto, March 8 to 10.

THE FARADAY SOCIETY (London) will hold a joint meeting, March 1, with the London Section of the Society of Chemical Industry to receive and discuss a report of Dr. T. Martin Lowry, and E. C. Hemmings on the "Setting of Salts and Other Crystalline Substances." Another meeting will be held March 23, at which there will be a general discussion on "Basic Slag From the Metallurgical and Agricultural Standpoints."

THE INSTITUTE OF METALS will hold its annual general meeting March 11 and 12 at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S. W. 1, London, England.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect.

THE MATERIAL HANDLING MACHINERY MANUFACTORERS' ASSOCIATION will hold its convention at the Waldorf-Astoria Hotel, New York City, Feb. 26 and 27.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its spring meeting at the Hotel Waldorf and the Hotel Astor, New York City, April 12 to 16.

Industrial Notes

THE TRUSCON STEEL CO. has opened a branch sales office in El Paso, Tex., and is carrying a stock of $100,000 in plates and girder connection. W. A. E. Wood is the local manager.

THE UNITED STATES RUBBER CO. has acquired the plant and business of the Dolgeville Felt Shoe Co., Dolgeville, N. Y. The present management will be continued.

THE MINE & SMELTER SUPPLY CO., Denver, Col., announces that W. A. Leddell has been appointed manager of its engineering department, with headquarters in Denver. Problems relating to Marcy mills, Wilfley tables and other Massco specialties and the preparation of flow sheets and specifications will come under the supervision of Mr. Leddell's department.

THE HAUCK MFG. CO., Brooklyn, N. Y., manufacturer of oil burners, has recently made some changes in the location of its burner service stations, for the purpose of improving its facilities for service and demonstration. The Pittsburgh station has been moved from 2930 Penn Ave. to 105 Wood Street; the Boston station from 70 Hight St. to 149 Berkeley St., cor. Columbus Ave.; the Cleveland station from 2114 Superior Viaduct to 1106 Walnut Ave.

JOHN JOHNSON CO., Brooklyn, N. Y., manufacturer of filter presses, announces that it has acquired the services of Colonel M. E. Brewster-Green, who has recently returned from two years' staff duty in France and Italy. Colonel Green was formerly assistant advertising manager for the Locomobile Co. of America.

THE ELECTROLABS CO., New York, announces the consolidation of all offices at 2635 Penn Ave., Pittsburgh, Pa. A branch office is maintained at 30 Church St., New York City.

HUMMEL & ROBINSON, New York, advises that arrangements have been made with W. R. Sturges to act as its representative and agent for the Southern territory for the sale of dry colors and chemicals. Mr. Sturges was formerly with Reichard-Coulston, Inc., New York.

BUTTERWORTH-JUDSON CORP., New York, announces the following appointments: Fred E. Signer, general sales manager, vice W. H. Clark, resigned; E. A. MacKinnon, assistant sales manager; J. D. Lowery, assistant sales manager, and George E. Green, traffic manager.

THE BOOTH ELECTRIC FURNACE CO. has opened a Detroit office in charge of M. A. Beltaire, Jr., with headquarters at 805 Hammond Bldg. and an office in Birmingham, Ala., in charge of Gassman & Cunningham, in the Brown & Marx Bldg.

THE PHOENIX IRON WORKS CO., Meadville, Pa., announces the appointment of K. B. Thorndike as sales engineer, in charge of its New York office, Fifth Ave. Bldg.; also the opening of a Boston office in the Old South Bldg., with Paul C. Rodgers, district sales manager, in charge. These changes are in line with the policy of this company, in order to make its branch offices of service to its customers not only as sales offices but also from an engineering standpoint.

THE CHICAGO PNEUMATIC TOOL CO. on Jan. 21 and 22 held a general conference of executives, plant and branch managers and salesmen at its Detroit plant, on the occasion of the formal opening of a large five-story addition.

THE MANSFIELD CLAY PRODUCTS CO., Mansfield, Ohio, has changed its name to the Mansfield Shale Products Co., the change being deemed advisable inasmuch as the operations of the company are confined chiefly to shale.

THE AMERICAN METALLURGICAL CORP., Philadelphia, Pa., at the annual stockholders' and directors' meeting elected the following officers and directors for the coming year: F. J. Ryan, president; S. R. Vanderbeck, vice-president; W. L. Taylor, treasurer; J. L. Hawley, assistant treasurer, and S. H. Ourbacker, secretary.

THE BURRELL TECHNICAL SUPPLY CO., INC., Pittsburgh, Pa., has been organized to conduct a general laboratory and technical supply business. A catalog devoted entirely to apparatus for gas analysis will soon be off the press. The officers of the company are Colonel G. A. Burrell, president; J. T. Ryan, vice-president; G. H. Deike, treasurer, and G. C. Nelms, secretary.

"THE NURSE IN INDUSTRY" is the title of a pamphlet published by the National Organization for Public Health Nursing, 156 5th Ave., New York City. Copies will be sent on request to those who are interested in the work of industrial nurses.

THE STEEL BARREL MANUFACTURERS ASSOCIATION held its annual meeting in Chicago in December. The activities of the Association during 1919 included efforts to standardize the different types of steel barrels and drums as well as size of threads and character of flanges and plugs. The committee having this in charge cooperated with the Bureau of Explosives and recommendations have been made for strengthening the I. C. C. specifications. The committee on minimum weights and various styles of packages did considerable work to protect the buyer from unscrupulous manufacturers. Other committees reported on publicity, legislation, railroad rates, and cost-accounting systems. The officers elected for the ensuing year were: G. A. Moore of the Detroit Range Boiler & Steel Barrel Co., president; Mr. Kinney of the Metal Barrel Corp., vice-president, and D. S. Hunter, secretary-treasurer.

THE JOSEPH BROWN CO., of Woonsocket, R. I., has been organized to manufacture chemicals, etc. The capital stock of the company is $100,000, and the incorporators are as follows: Joseph Brown, Arthur H. Heen and Arthur B. Martel, all of Woonsocket, R. I. All are experienced in the line of chemical goods, and business will be engaged in shortly. All communications should be addressed to Joseph Brown, care of Joseph Brown Co., Woonsocket, R. I.

New Publications

WAR INDUSTRIES BOARD Bull. 34. "Prices of Ferro-Alloys, Non-ferrous and Rare Metals," by H. R. Aldrich and Jacob Schmuckler.

GLUE USED IN AIRPLANE PARTS, Report No. 66, issued by the National Advisory Committee for Aëronautics, Washington, D. C.

THE ELECTRIC FURNACE is the title of a 16-page magazine published by the Electric Furnace Co., Alliance, Ohio. Vol. 1, No. 1, is dated January, 1920, and is to be succeeded by monthly issues.

THE NATIONAL RESEARCH COUNCIL of the National Academy of Sciences, Washington, D. C., has started the *Bulletin* of the National Research Council, which is to appear at irregular intervals. Vol. 1, Part 1, No. 1, dated October, 1919, has appeared. In this issue the national importance of scientific and industrial research is discussed by George E. Hale, Elihu Root, Henry S. Pritchett, Theodore N. Vail, Ambrose Swasey, A. W. Mellon, George Eastman, Walter Douglas, James R. MacColl and H. W. Howe.

THE REPORT ON PROPAGATION OF FLAME IN PIPES AND EFFECTIVENESS OF ARRESTORS, which is Special Investigation Series No. 528, dated Oct. 1, 1919, has been issued by the Underwriters Laboratories, Chicago, Ill.

METALLURGICAL PATENTS OWNED BY THE CHEMICAL FOUNDATION, INC., 81 Fulton St., New York City. This pamphlet contains abstracts of patents seized by the Alien Property Custodian and sold to the Chemical Foundation. Copies of the patents are available for examination at the office of the Chemical Foundation, Inc.

VAT DYE PATENTS OWNED BY THE CHEMICAL FOUNDATION, INC., 81 Fulton St., New York City. This pamphlet contains abstracts of patents seized by the Alien Property Custodian and sold to the Chemical Foundation. Copies of the patents are available for examination at the office of the Chemical Foundation, Inc.

Manufacturers' Catalogs

THE OXYGEN GAS CO., Kansas City, Mo., has issued pamphlets on "Oxygen and Hydrogen Gases," with particular reference to the use of hydrogen for oil hardening, and on the "Advantages of Nitrous Oxid-Oxygen as an Anesthetic."

THE BLAW-KNOX CO., Pittsburgh, Pa., has recently issued a new Blawforms folder, illustrating the application of Blaw steel forms for concrete construction.

VIELE, BLACKWELL & BUCK, New York City, have issued a series of bulletins which should prove of value to companies engaged in foreign trade. The organization maintains an engineering section to design, purchase and conduct all classes of industrial plants and a foreign trade section which handles both for export and import a great variety of raw, semi-finished and finished products, which are listed in Bulletin A. In other bulletins the company has compiled a vast amount of information on ferrous and non-ferrous metal products and heavy chemicals.